

*Shelved in Stacks S.P.T.*

# Highway Safety Literature

*LSP-IL*  
An Announcement  
of Recent Acquisitions . . .

HSL No. 71-27  
October 22, 1971



#### THIS ISSUE CONTAINS:

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# HIGHWAY SAFETY LITERATURE

## AN ANNOUNCEMENT OF RECENT ACQUISITIONS

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Washington, D.C. 20590

### INTRODUCTION

Publications announced in *Highway Safety Literature* include the most recent additions to the collection of the NHTSA Scientific & Technical Information Service. Subject areas covered include all phases of highway, motor vehicle, and traffic safety, especially those encompassed by the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.

Individual issues of *HSL* are numbered according to the year and the issue number within that year; thus, 71 designates the year and 1, 2, 3, etc. the individual issues. To aid the user in location citations by the HS-number, the cover bears the inclusive entry numbers for each issue.

Entries in *HSL* are arranged according to the revised NHTSA Subject Category List shown in the Table of Contents. The list is a two-level arrangement consisting of five major subject fields subdivided into 59 subject groups. Documents related directly to the National Highway Traffic Safety

Administration (NHTSA) are announced in a separate section headed NHTSA DOCUMENTS and are numbered in five distinct series: NHTSA Accident Investigation Reports (HS-600 000 series), NHTSA Compliance Test Reports (HS-610 000 series), NHTSA Contractors Reports (HS-800 000 series), NHTSA Staff Speeches, Papers, etc. (HS-810 000 series), and NHTSA Imprints (HS-820 000 series). For NHTSA DOCUMENTS in series HS-600 000 and HS-610 000, individual full case reports are available for inspection at the National Highway Traffic Safety Administration. HS-800 000 series and HS-820 000 series are available for sale/or purchase from NTIS or GPO (see page ii). Although announced together in a separate section, these documents are also assigned specific subject categories for machine retrieval.

A document which contains a number of separate articles is announced as a complete volume in the subject category most applicable to it as a whole. Entries for the individual articles appear in their most specific subject category.

### SAMPLE ENTRIES

#### Subject Category Array

NHSB Accession no..... HS-800 218 Fld. 5/21; 5/9  
Title of document..... AN INVESTIGATION OF USED CAR SAFETY STANDARDS-SAFETY INDEX: FINAL REPORT. VOL. 6 - APPENDICES G-L  
Personal author(s)..... by E. N. Wells; J. P. Fitzmaurice; C. E. Guiliams; S. R. Kalin; P. D. Williams  
Corporate author..... Operations Research, Inc.

#### Collation

Publication date..... 12 Sep 1969 150p  
Contract FH-11-6921  
Report no. ORI-TR-553-Vol-6; PB-190 523

Abstract..... Appendices G-L to this study of used car safety standards include: indenture model diagrams for classes I-IV motor trucks; degradation, wear, and failure data for motor truck classes I-IV; and safety index tables for classes I-IV motor trucks.

Search terms; Wear; Trucks; Failures; Used cars; Inspection standards

**HS-004 497 Fld. 5/19**

**AUTO THEFT-THE PROBLEM AND THE CHALLENGE**

by Thomas A. Williams, Sr.

Journal citation . . . Published in *FBI Law Enforcement Bulletin* v37 n12 p15-7 (Dec 1968)

Gives figures on the extent of the auto theft problem and comments on antitheft devices available now or in the planning stage.

Search terms: Theft; Theft protection; Stolen cars

AVAILABILITY: NTIS

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**NOTE:** Material published in Highway Safety Literature (HSL) is intended for the information and assistance of the motor vehicle and highway safety community. While brands names, equipment model names and identification, and companies may be mentioned from time to time, this data is included as an information service. Inclusion of this information in the HSL should not, under any circumstances, be construed as an endorsement or an approval by the U. S. Department of Transportation, National Highway Traffic Safety Administration of any particular product, course, or equipment.

Harry A. Feinberg  
Managing Editor

## AVAILABILITY OF DOCUMENTS AND INSTRUCTIONS FOR ORDERING

Department of Transportation personnel may borrow copies of publications directly from the NHTSA. Outside the Washington, D.C. area, phone (202) 426-2768. In Washington, D.C. area, use government ID, phone 118-62768. Non-DOT personnel should contact their company or agency libraries for assistance.

Journals cite<sup>r</sup> may be obtained through most research libraries.

Contractors' reports and other documents can usually be obtained as indicated under AVAILABILITY. However, there is no certainty that retention copies will be available for more than a limited period after a document is issued.

The more common distribution sources are identified by symbols which are explained below:

**NTIS:** National Technical Information Service, Springfield, Va. 22151. *Order by accession number: HS, AD, or PB.* Prepayment is required by NTIS (CFSTI) coupon (GPO coupons are not acceptable), check, or money order (made payable to the NTIS), *HC* (Paper copy; full size original or reduced facsimile) \$3.00 up; *MF* (microfiche approximately 4x6" negative sheet

film; reader required) \$0.95.

**GPO:** Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402. Give corporate author, title, personal author, and report number. Prepayment is required by GPO coupon (NTIS [CFSTI] coupons are not acceptable), check or money order (made payable to the Superintendent of documents).

**HRB:** Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418.

**NHTSA:** National Highway Traffic Safety Administration General Services Division, Washington, D.C. 20591 (Telephone (202) 426-0874),

**SAE:** Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. Order by SAE report numbers. Prices given are list; discounts are available to members and sometimes to libraries and U. S. Government Agencies. Prepayment is required; orders without payment are subject to a \$1 handling charge.

### IMPORTANT NOTICE

WHEN REQUESTING a document, to be absolutely sure you receive what you order, give the accession number (HS, PB, AD number) or report number (in cases such as an SAE document), title of report, and the personal or corporate author (whichever is cited). When requesting an HS-numbered document from NTIS (CFSTI), add DOT/to the prefix HS; example HS-800 000 should be ordered as DOT/HS-800 000.

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ACCIDENTS

1/0 ACCIDENTS

1/3 Investigation

HS-009 916 Fld. 1/3

CLASSIFYING ACCIDENTS BY  
SOCIOLOGICAL VARIABLES  
FOR EDUCATIONAL RESEARCH

by Francis S. McGlade; S. A. Abercrombie

Published in *Behavioral Research in Highway Safety* v1 n4 p250-7 (Winter 1970)

4 refs  
Grant PHS-AC-72

Accident data on a school-age population of 16,000 children were studied. Two aspects of overall accident prevention will have an impact on accidents, including traffic incidences. These are the social configurations in which accidents occur and the utilization of these data for the development of content and curricula imputs for all educational grade levels. Within the behavioral science framework, psychologists often have talked about transitional emotional states as an important component in accident causation; this paper suggests, from a sociological point of view, that there is an implied social milieu in which accidents occur. Using the models suggested by the authors, it was shown that females more often have their accidents in a non-social context. Further data breakdowns suggest that accidents consistently vary by the activity situation, social nature, sex, and developmental level. This perhaps implies the need for more homogeneous grouping of students so that educational content can be more specific.

Search terms: Accident prevention; Age factor in accidents; Sex factors in accidents; Sociological factors; Accident types; Accident responsibility; Children; Accident studies

HS-009 917 Fld. 1/3

MOTOR CARRIER ACCIDENT  
INVESTIGATION. CRIST

TRUCKING, ACCIDENT—  
SEPTEMBER 16, 1970—MARION,  
ARKANSAS

Bureau of Motor Carrier Safety

June 1971 10p  
Report no. 70-9

On September 16, 1970, at 3:15 a.m., on Interstate 55, four miles north of Marion, Arkansas, a tractor-semitrailer combination (truck) operated by Crist Trucking, of Palmyra, Illinois, left the road, crossed the median strip, the south-bound traffic lanes and service road, then collided with the concrete bridge support. The truck was demolished and the driver was killed. The accident causes were a tire blow-out (the tires were found to be in deplorable condition) and an underaged and inexperienced driver. The driver was 18 years of age, already had six violations on his record, and had been driving 14 hours without rest.

Search terms: Tire failure caused accidents; Loss of control; Accident case reports; Truck accidents; Fatalities; Driver experience; Adolescent drivers; Truck drivers; Tire maintenance; Tire failures; Driver records; Sleep deprivation

HS-009 918 Fld. 1/3

MOTOR CARRIER ACCIDENT  
INVESTIGATION. LITTLE  
AUDREY'S TRANSPORTATION  
CO., INC., ACCIDENT—AUGUST  
31, 1970—CIRCLE CITY,  
ARIZONA

Bureau of Motor Carrier Safety

May 1971 12p  
Report no. 70-7

On August 31, 1970 at 6:15 a.m., on U.S. Highway 60, near Circle City, Arizona, a tractor semitrailer ran off the road, struck a guardrail and bridge parapet, and burst into flames. The truck then crossed into the opposite lane of traffic, striking a passenger vehicle head-on. Five persons were killed, including

two unauthorized passengers in the truck. Accident cause was: unqualified truck driver, with a bad record of violations, driving after his license was revoked, who was inattentive or dozing.

Search term: Truck accidents; Vehicle fixed object collisions; Centerline crossover collisions; Accident caused fires; Vehicle fires; Accident case reports; Attention lapses; Driver license revocation; Fatalities; Traffic law violators; Truck drivers; Head on collisions; Driver records

HS-009 919 Fld. 1/3

HIGHWAY ACCIDENT REPORT.  
AIRPORT TRANSPORT BUS—  
AUTOMOBILE COLLISION,  
DULLES AIRPORT ACCESS  
ROAD, JUNE 9, 1970

National Transp. Safety Board

30 Dec 1970  
Report no. NTSB-HAR-71-2

On June 9, 1970, at 4:40 p.m., a 1965 Mercury two-door hardtop sedan, operated by a man under the influence of alcohol, driving west (wrong way) on the Dulles Airport Access Road crashed head-on into the right front of an eastbound 41 passenger 1967 GMC Model 4107 Greyhound Airport Service Bus. Both vehicles were traveling at 65 mph prior to impact. The Mercury then pivoted counterclockwise 180° and struck an eastbound 1969 Ford Econoline Van on the left front side. The Safety Board determined that the probable cause of this accident was driver error in that an automobile was driven the wrong way on a dual highway by a driver under the influence of alcohol. The driver of the auto was killed, and one bus passenger died later. Fourteen occupants of the bus and van were injured. No seat belts were being used by any of the drivers or passengers.

Search terms: Drinking drivers; Head on collisions; Side impact collisions; Bus accidents; Wrong way driving

## ACCIDENTS

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### 1/3 Investigation (Cont'd.)

#### HS-009 919 (Cont'd.)

Passenger injuries; Driver emergency responses; Fatalities; Ejection; Seat belt usage; Driver fatalities; Passenger fatalities; Driver intoxication; Accident case reports

AVAILABILITY: NTIS \$3.00; MF \$0.95

#### HS-009 920 Fld. 1/3

### THE MEANING OF DRIVING EXPOSURE

by Philip S. Carroll

Published in *HIT Lab Reports* p1-3 (Apr 1971)

11 refs

A clear definition of driving exposure is needed for coordinated accident research. The proposed definition states: driving exposure is the frequency of traffic events which create a risk of accident. The most common measure of the *amount* of exposure is vehicle miles of travel, which is proportional to the frequency of traffic events if such events occur in a continuum with constant risk. Likewise, driving time or traffic volume may also measure the amount of exposure. Measures which characterize the *nature* of exposure may be developed using varying risks of traffic events. Exposure data are most useful when classified in groups by system variables.

Search terms: Accident risk forecasting; Accident risks; Accident causes

#### HS-009 921 Fld. 1/3

### MINI BIKES ARE "IN"

by Fair Miller

Published in *Traffic Safety* v71 n6 p16-7, 37 (June 1971)

Mini-bikes' soaring popularity (estimated sales 620,000 for 1971) leads to more

deaths and injuries every year. Most accidents occur when young riders, operating illegally on public streets, collide with motor vehicles. Victims are usually between 9 and 15 years old; one fatality was a 4-year-old. Safety could be promoted by discouraging advertising that incites showing off and stunting, by providing instruction in safe riding, and by setting aside safe riding areas.

Search terms: Fatalities; Child safety education; Minibikes; Child injuries; Advertising; Vehicle motorcycle collisions

### 1/5 Statistical Data

#### HS-009 922 Fld. 1/5

### DEATH AND INJURY ROAD ACCIDENTS IN NORTHERN IRELAND, 1970

Royal Ulster Constabulary (Northern Ireland)

1971 55p

Cover title: Road accident statistics.

This statistical analysis indicates that there was an increase of 6.6% in the number of accidents, an increase of 5.8% in the number of persons killed, and an increase of 10.9% in the number of persons injured in 1970, compared to the previous year. A number of graphs and tables gives details as to the accident factors, child accidents, time of day, age factors, pedestrians, cyclists, accident responsibility, vehicle defects, weather, road condition, types of road. Accident statistics from 1931 to 1970 are included.

Search terms: Accident statistics; Fatalities by age; Accident factors; Accident causes; Children; Environmental factors; Accident responsibility; Bicycle accidents; Pedestrian accidents; Motorcycle accidents; Defective vehicles; Time of day; Time of accidents; Northern Ireland; Injury statistics; Injuries by age; Age factor in accidents

#### HS-009 923 Fld. 1/5

### PORTRAIT OF A YEAR. A STUDY OF MICHIGAN'S 1967 AUTO INJURIES AND FATALITIES

Automobile Club of Michigan

1968 27p

The chief aim of this 1967 study was to find the similarities and differences between fatal and injury accidents. Driver error again remained the single greatest contributing factor in accidents. Alcohol appears to be one of the factors that spell the difference between injury and death. Alcohol was involved in 44% of the fatal accidents and 10.5% of injury accidents. Speed and accident location turn injury accidents into fatalities. Use of seat belts prevented some of these injury accidents from becoming fatalities. Driver inattention was involved in a lot of injury accidents. Single car accidents were the largest single cause of injuries.

Search terms: Accident statistics; Accident location; Fatality rates; Injury rates; Drinking drivers; Age factor in accidents; Driver error caused accidents; Attention lapses; Seat belt usage; Single vehicle accidents; Speed; Driver intoxication; Driver age; Driver sex; Driver records; Michigan

#### HS-009 924 Fld. 1/5

### PORTRAIT OF A YEAR. WHAT HAPPENED ON MICHIGAN'S HIGHWAYS IN 1968

Automobile Club of Michigan

Apr 1969 46p

A study of fatal accidents that occurred during six weekends in 1968 found that 72% of the drivers involved in fatality accidents had been drinking, and it is recommended that the implied consent law should be improved; that 67% of injured children were car passengers, showing a need for better child restraint systems; that police traffic law enforcement is inadequate; that accident repeater drivers are not being controlled

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adequately; that over 70% of fatal accidents occurred on two-lane roads, on which speed limits should be reduced; that drivers under 21 were involved in 25% of the fatal accidents; that vehicle defects as an accident cause are nearly non-existent; that motorcycles and motorbikes were involved in a growing number of fatalities. Traffic safety recommendations based on the study are included. Accident statistics and the records of the 10 worst drivers are given.

Search terms: Michigan; Fatality rates; Accident statistics; Accident location; Driver records; Young adult drivers; Traffic law enforcement; Motorcycle accidents; Accident repeater drivers; Age factor in accidents; Problem drivers; Motor scooter accidents; Accident causes; Child injuries; Adolescent drivers; Driver experience; Child restraint systems; Two lane roads; Implied consent laws; Speed limits; Defective vehicles; Drinking drivers

HS-009 925 Fld. 1/5

### AUTO-PEDESTRIAN TRAFFIC ACCIDENTS IN ILLINOIS—1964

Illinois Div. of Highways

Sep 1965 11p

Auto-pedestrian fatal accidents accounted for 18.6 percent of all fatal accidents in Illinois during 1964. Persons killed in these accidents represented 15.8 percent of all traffic fatalities. Charts depicting the auto-pedestrian and all other accidents by time of day, day of week, killed and injured, age group, and sex are included.

Search terms: Pedestrian injuries; Illinois; Pedestrian fatalities; Day of week; Month; Driver sex; Pedestrian accidents; Vehicle pedestrian collisions; Accident statistics; Time of accidents; Age factor in accidents; Sex factors in accidents

HS-009 926 Fld. 1/5; 1/3; 3/4

### SURVEILLANCE OF FATAL MOTOR VEHICLE ACCIDENTS

### IN MICHIGAN, INVOLVING YOUNG DRIVERS, UTILIZING TIME-SERIES ANALYSIS OF POLICE RECORDS

by Stanley H. Schuman; M. Anthony Schork; Songsee Srivannaboon

Published in *Accident Analysis and Prevention* v2 n4 p315-34 (1971)

8 refs

Epidemiologic surveillance techniques were applied to the fatal motor vehicle accident records of the Michigan State Police for 1961-68. A base line of rates for several recent years was developed to improve police surveillance, program development, and objective evaluation. A time-series graph of three year, three week moving means was plotted from the numbers (or rates) of drivers involved in fatal motor vehicle accidents. Acute effects (as rates for holidays and weekends) are smoothed, but sustained peaks are clearly indicated. Thus, for drivers of all ages, significant summer and fall increases in accidents suggest increases in miles driven. Fatal accident involvement increased for drivers aged 18-19 in 1968 compared to 1967, and a three year plot (1964-65-66) indicates a significant spring upswing in fatal crashes of teenagers in April-May-June, suggesting seasonal target for police-and-educational countermeasures.

Search terms: Epidemiology; Adolescent drivers; Statistical analysis; Time series analysis; Accident statistics; Accident research; Age factor in accidents; Fatality rates; Fatalities by age; Month; Seasons; Young adult drivers; Michigan; Single vehicle accidents; Accident rates; Safety programs; Driver mileage

HS-009 927 Fld. 1/5; 3/10

### COMPARISON OF DRIVER AGE WITH NUMBER OF PASSENGERS AND PASSENGER AGES

by William T. Pollock

Published in *HIT Lab Reports* p11-2 (Oct 1970)

Accident frequency was studied as a function of driver age, with parameters being number of passengers and passengers' ages for each vehicle involved in a single vehicle crash, and for each striking vehicle in multi-vehicle crashes. Plots of these data show the high frequency of accidents among teenage drivers. The incidence of accidents decreases with age and number of passengers.

Search terms: Accident statistics; Single vehicle accidents; Driver age; Passengers; Age factor in accidents; Adolescent drivers; Accident rates; Adult drivers

## 2/0 HIGHWAY SAFETY

HS-009 928 Fld. 2/0

### MANPOWER DEVELOPMENT—WHOSE BABY?

by Charles H. Hartman

National Hwy. Traf. Safety Administration

Published in *Traffic Safety* v71 n5 p22-4, 37 (May 1971)

The needs for trained manpower in the highway safety field are described. Manpower development policies and plans in the National Highway Traffic Safety Administration are discussed. Highway safety programs and priorities depend on availability of qualified people.

Search terms: Manpower utilization; Priorities; Personnel management; Highway safety programs; National Highway Traffic Safety Administration

## 2/1 Breakaway Structures

HS-009 929 Fld. 2/1; 2/5

### COLLISION TESTS WITH BREAKAWAY STREET LIGHTING COLUMNS FITTED WITH A SUSPENSION CABLE

by H. J. Hignett; A. E. Walker

**2/1 Breakaway Structures  
(Cont'd.)****HS-009 929 (Cont'd.)**

England Road Res. Lab.

1971 22p 8 refs

Report no. RRL-LR-387

Low speed and high speed collision tests have been carried out to investigate the feasibility and effectiveness of connecting the tops of breakaway columns by a steel suspension cable so that after a collision the shaft of the column involved in left suspended between the two adjacent columns, and does not fall onto the carriageway or footpath. The tests showed that a suspension cable can be easily attached to the tops of breakaway columns, and the restraint put on the columns does not significantly increase the damage to the car or to the risk of serious injury to occupants. Due to the large final deflection of the suspension cable there is a risk of the lower end of the column obstructing the opposite carriageway after a collision if this type of installation without barriers is used on a 4 m central reserve of a dual carriageway road. It also appears that after an impact adjacent columns would need to be examined and the flange bolts changed.

Search terms: Breakaway light poles; Pole impact tests; Vehicle light pole collisions; Low speed impact tests; Test equipment; Deformation; Impact forces; Breakaway structures

**2/4 Design and Construction****HS-009 930 Fld. 2/4****HIGHWAY ENVIRONMENTAL  
SAFETY DESIGN PRACTICES: A  
TOPICAL REVIEW**

by Wayne T. Vanwaggoner

Published in *Highway Research Record*  
n332 p14-27 (1970)

17 refs

Presented at HRB 49th annual  
meeting.

Highways currently being designed and constructed contain safety hazards resulting from a lack of detailed information concerning some environmental features. A continuing study of all aspects of highway collisions is being conducted at the University of Utah in an effort to locate and define safety hazard areas in the vehicle, driver, and environment. Environmental roadway and roadside safety hazards in relation to longitudinal and cross-sectional elements are discussed from the collision causation and collision severity point of view. It was found that often the intent of safety standard suggestions was ignored in favor of strict standard adherence. It is concluded that a lack of communication exists between the highway designer and the safety researcher. It was also concluded that each highway must be designed with respect to the intent as well as the "letter" of suggested safety standards. The recommendation is made that a group of engineers and designers be created in each state for the purpose of coordinating and reviewing designs from a safety point of view.

Search terms: Safety design; Lane width; Highway characteristics; Highway design; Highway signs; Highway engineering; Guardrail design; Accident causes; Slopes; Multidisciplinary teams; Highway safety standards; Barrier design; Medians; Driver road interface; Environmental factors; Roadside hazards; Fixed objects; Landscaping

**2/5 Lighting****HS-009 931 Fld. 2/5****SUMMARY OF CURRENT  
STATUS OF KNOWLEDGE ON  
RURAL INTERSECTION  
ILLUMINATION**

by M. E. Lipinski; G. C. Meador; A. L. Gilbronson; M. L. Traylor; W. D. Berg; C. L. Anderson; R. H. Wortman

Published in *Highway Research Record*  
n336 p33-62 (1970)

73 refs

The purpose of this report is to review the status of knowledge as of June 1968 regarding roadway illumination at rural at-grade intersections and to summarize current practices. Over 300 references have been reviewed. Information from 49 state highway departments and from literature review is summarized in regard to the history of street lighting, accident reduction benefits from improved lighting, traffic capacity improvement from lighting. Factors in the design of lighting systems are discussed, including night visibility, night vision, glare, pavement reflectance, level and uniformity of illumination, photometric data, types and costs of lighting.

Search terms: Highway lighting; Rural lighting; Intersection lighting; Street lighting; Glare; Benefit cost analysis; Pavement reflectivity; Lighting design; Lighting equipment; Lighting equipment costs; Night vision; Night visibility; Reviews; Traffic capacity; Rural intersections; Highway improvements; Accident rates; Photometry

**HS-009 932 Fld. 2/5****TRENDS IN LIGHTING AND  
LIGHT SOURCES FOR TRAFFIC  
ROADS**

by J. B. de Boer

Philips' Gloeilampenfabrieken N.V.  
(Netherlands)Published in HS-009 946, *Visibility and Driving*, Berkeley, 1969 p25-46

7 refs

Presented at 2nd annual Symposium on Visibility and Driving, Berkeley, 8-10 Jul 1969.

The basic characteristics determining the quality of traffic road lighting are: the lighting level, the uniformity of this level, the restriction of glare, and the support given by the lighting installation to the optical guidance obtained from the alignment of the road. A basis for internationally acceptable deviations from lighting uniformity and glare re-

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strictions is put forward. The paper also discusses application of the basic concepts to the problem of lighting motorway interchanges in the Netherlands. Illustrations of the interchanges are included.

Search terms: Highway lighting; Night visibility; Brightness; Luminance; Glare reduction; Night driving; Intersection lighting; Netherlands; Lighting equipment

**HS-009 933 Fld. 2/5; 1/3**

### RELATIONSHIP BETWEEN ILLUMINATION AND FREEWAY ACCIDENTS. PROJECT 85-67

by Paul C. Box; Willard A. Alroth

Published in *IERI Report v66 n5 p365-93* (May-Jun 1971)

12 refs

The objective of this research was to determine the optimum design illumination level and uniformity needed on urban freeways, as related to accident rates. Data were collected from a wide variety of freeways, and compared by using the ratio of night/day accident rates per million vehicles miles. The tabulations included other factors, such as roadway elements, weather, driver age, and types of accidents, which would allow subsequent analysis as separate research. Conclusions are presented concerning daylight threshold, night traffic, lighting warrants, illumination values, lighting depreciation, roadway elements, driver age, data acquisition, and recommended future research.

Search terms: Highway lighting; Lighting measurement; Lighting warrants; Night driving; Accident rates; Accident types; Accident severity; Statistical analysis; Data acquisition; Twilight driving; Day vs night accidents; Urban lighting; Traffic volume; Driver age; Lighting design; Highway characteristics; Freeway driving; Vehicle mileage; Traffic characteristics; Benefit cost analysis

### 2/7 Meteorological Conditions

**HS-009 934 Fld. 2/7**

### A CASE STUDY OF FOG DISPERSAL

by Roland J. Pilie; Warren C. Kocmond

Cornell Aeronautical Lab., Inc.

Published in HS-009 946, *Visibility and Driving*, Berkeley, 1969 p3-6

Presented at 2nd annual Symposium on Visibility and Driving, Berkeley, 8-10 Jul 1969.

The purpose of this brief discussion is to illustrate, by means of a case study, how information acquisition by a driver in a fog can be improved by modifying the fog rather than the objects that the driver must observe. The experiments were actually performed at an airport as part as a study aimed at improving landing conditions for aircraft. These fog modification techniques show promise for highway application, at least for localized conditions such as clearing fog from a dangerous intersection or clearing short stretches of highway during rush hour. Helicopters might seed fogs near an accident scene to help prevent multiple vehicle crashes or to bring medical aid to the injured.

Search terms: Fog dispersal; Cloud seeding

**HS-009 935 Fld. 2/7; 2/9**

### FOG WARNING SIGN SYSTEM

by L. E. George

Oregon State Hwy. Dept.

Published in HS-009 946, *Visibility and Driving*, Berkeley, 1969 p23-4

Presented at 2nd annual Symposium on Visibility and Driving, Berkeley, 8-10 Jul 1969.

A high accident location where environmental factors combine to encourage fog

formation is described and the preliminary results of installing remote controlled fog warning signs are reported.

Search terms: Fog; Fog warning systems; Reduced visibility

**HS-009 936 Fld. 2/7; 3/8**

### PHYSICS AND DISTRIBUTION OF FOG

by Warren C. Kocmond; Roland J. Pilie; William J. Eadie

Cornell Aeronautical Lab., Inc.

Published in HS-009 946 *Visibility and Driving*, Berkeley, 1969 p11-17

12 refs

Presented at 2nd annual Symposium on Visibility and Driving, Berkeley, 8-10 Jul 1969.

This report considers warm fog, super-cooled fog, and ice fog, how they are formed, the physical compositions, theory of visual range, and climatic survey of fog frequency.

Search terms: Fog; Ice fog; Sight distances; Reduced visibility; Equations

## 3/0 HUMAN FACTORS

### 3/1 Alcohol

**HS-009 937 Fld. 3/1**

### LOCAL/FEDERAL APPROACH TO CURBING THE DRUNKEN DRIVER

Anonymous

Published in *Journal of American Insurance v46 n4 p4-7* (Sep-Oct 1970)

Steps being taken in nine pilot areas to get chronic drinking drivers off the roads are described. They include passage of implied consent laws, identification and

## HUMAN FACTORS

HSL No. 71-27

### 3/0 HUMAN FACTORS (Cont'd.)

#### HS-009 937 (Cont'd.)

treatment of problem drinkers, driver education concerning drunk drivers, improvement of driving skills, and research into the drinking problem. One such program, being implemented in Washtenaw County, Michigan, is described. Alcoholics are receiving treatment with Antabuse.

Search terms: Drinking drivers; Alcohol laws; Alcohol usage deterrents; Disulfiram; Alcoholism; Alcohol education; Driver rehabilitation; Michigan; Implied consent laws

#### HS-009 938 Fld. 3/1

### THE DRINKING DRIVER: CHICAGO'S QUEST FOR A NEW ETHIC

by Alexander C. Field, Jr.

Published in *Traffic Digest and Review*  
v19 n5 p1-6 (May 1971)

In Chicago, a study of persons arrested for drunk driving was conducted. Such persons were sent to the Psychiatric Institute for individual examination. The study revealed that not more than 20% convicted were alcoholics--the percentage of repeated convictions corresponds almost exactly to the number of true alcoholics. The social drinker accounts for 80 percent of the offenders. It was concluded that in 80% of the cases, rehabilitation is not an issue. The program for drinking drivers should be one of prevention. During the Christmas-New Year holidays, a pilot program was undertaken: persons convicted of drunk driving would be jailed for a minimum of seven days and their licenses revoked for one year. As a result of this program, Chicago achieved a remarkable automobile safety record for the holidays.

Search terms: Alcohol usage deterrents; Alcohol education; Social drinking; Alcoholism; Drinking drivers

#### HS-009 939 Fld. 3/1

### CAN WE CURE THE ALCOHOLIC DRIVER

by William L. Roper

Published in *Highway Patrolman* v34  
n11 p4-5, 21-4, 26-8 (Jan 1971)

A proposed federal law, Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act, promises a concerted all-out attack to reduce the number of alcohol-related traffic accidents through grants to the various states to assist them in planning, establishing and maintaining projects for alcoholism treatment and rehabilitation programs. These grants will be administered through a new National Institute for Alcohol Abuse and Alcoholism. A three-pronged attack will be made on the problem: education to prevent persons from becoming alcoholics, treatment of those addicted, and rehabilitation of the victims to restore them to a useful role in society. Some of the problems involved in administering such a program effectively include a need for public support.

Search terms: Drinking drivers; Alcoholism; Alcohol laws; Alcohol education; Driver rehabilitation; Alcohol usage deterrents; Federal laws; Community support

In a laboratory experiment studying attitude change, the contributions of communication content ("present car design is responsible for road fatalities" versus "highways and drivers are responsible for safety"), type of media (press versus radio), and distribution of media (local versus national) to attitude change regarding car safety responsibility, it was found that no strong media effects were observed when the media acted as a forum for opinions rather than taking content responsibility. Communication content had a very strong effect, while a considerable portion of the attitude change exhibited was a function of the subjects' predisposition to persuasibility and the opinion change correlated significantly with authoritarianism and need for social approval. When a correction for authoritarianism was carried out, significant media effects were revealed. Retention of factual information in the communications was found to be markedly superior for press rather than radio although media prestige (national versus local distribution) was not influential.

Search terms: Psychological factors; Psychological tests; Attitudes; Behavior; Radio programs; Safety propaganda; Mass media; Public opinion; Accident responsibility; Motivation research; Variance analysis

#### HS-009 941 Fld. 3/4

### ON THE ROAD WITH THE HIGH-WAY PROS

by Tom Slaybaugh

Published in *Traffic Safety* v71 n4  
p18-9, 42 (Apr 1971)

The National Safety Council makes repeated references in its defensive driving course to the professionals of highway driving--the truckers. The author takes a trip with a trucker to take a first-hand look. He concludes that truck drivers are highly skilled.

Search terms: Truck drivers; Driver experience; Truck driver performance; Professional drivers

### 3/4 Driver Behavior

#### HS-009 940 Fld. 3/4

### COMMUNICATION, MEDIA, AND AUDIENCE EFFECTS UPON ATTITUDE CHANGE WITH REGARD TO AUTOMOBILE SAFETY RESPONSIBILITY

by R. A. Williams; L. S. Cousins; G. J. S. Wilde

Published in *Behavioral Research in Highway Safety* v1 n3 p155-71 (Fall 1970)

28 refs

OCTOBER 22, 1971

## HUMAN FACTORS

### HS-009 942 Fld. 3/4

#### ESTIMATION OF DISTANCE AND VELOCITY IN TRAFFIC SITUATIONS

by Sauli Hakkinen

Institute of Occupational Health (Finland)

May 1963 20p 13 refs  
Report no. 3; AD-837 800

Films were made of three different traffic situations and presented to a group of drivers for obtaining estimates of distance of stationary vehicle, velocities of an oncoming vehicle, and velocities of the driver's own vehicle (when filmed from behind the steering wheel). The last situation was repeated in the real environment. During the whole experiment, 250 drivers made 104 estimates each. It was found that the driver overestimates distances and underestimates velocities of both his own vehicle and other vehicles approaching him. Errors increased as distances and velocities increased. Two types of errors, overestimation of distances and underestimation of velocities, combine to the greatest possible disadvantage to vehicle operators. This seems to suggest that considerable training is required to overcome this psychophysical phenomenon.

Search terms: Oncoming vehicles; Velocity perception; Distance perception; Motion perception; Psychophysical discrimination; Driving simulation; Driving task analysis

### HS-009 943 Fld. 3/4; 2/7

#### DRIVING IN FOG

by Kenneth Perchonok

Cornell Aeronautical Lab., Inc.

Published in HS-009 946, *Visibility and Driving*, Berkeley, 1969 p7-10

8 refs

Presented at 2nd annual Symposium on Visibility and Driving, Berkeley, 8-10 Jul 1969. Abstracted in part from *Project Highway Fog Final Report*.

It appears that drivers are aware of fog as a hazard but they do not overtly respond in ways other than modest speed reductions. Traffic data from a rural highway show the speed reductions to be insufficient to preclude excessive overdriving. The data also show a failure to minimize interactions with other vehicles. The accident data, however, suggest that these problems become less severe when the driver expects to interact with other vehicles. The problem is most severe under conditions of overconfidence associated with limited access highways.

Search terms: Fog driving; Driver behavior; Speed reduction; Vehicle spacing; Reduced visibility; Sight distances; Driver performance under stress

### HS-009 944 Fld. 3/4; 2/10

#### THE EFFECT OF DIFFERENT TRAFFIC COURT SCHOOL INSTRUCTIONAL APPROACHES ON DRIVER ATTITUDE AND BEHAVIOR

by Frazier Damron; Philip A. Perrone; Ray E. Hosford

Published in *Traffic Digest and Review* v19 n6 p1-9 (Jun 1971)

30 refs

The psychology of driver control is an area in which not too many sociologists or psychologists have spent much time in research or experimentation to see just what effect our efforts at traffic law enforcement are having on the individual driver whose conduct we are trying to influence. Many in the field of traffic law enforcement have long advocated traffic safety schools as one effective method of educating the public to the necessity of driver understanding and observance of the traffic rules. These authors have approached the problem from more of a scientific angle than

most police-prosecutor-judge conferences have the capacity or factual research and experimentation to do. This study is based on results of a traffic school for young male adults sent by the courts in Madison, Wisconsin.

Search terms: Traffic courts; Driver improvement schools; Problem drivers; Driver behavior; Traffic law violators; Driver attitudes; Male drivers; Adolescent drivers; Young adult drivers; Driver attitude measurement; Driver education

### HS-009 945 Fld. 3/4; 3/6

#### PORTRAIT OF A BAD DRIVER

Automobile Club of Michigan

Nov 1970 59p

Study was made of the records of 269 Michigan drivers who were involved in fatality accidents from 1966 to 1969. Aspects of these problem drivers studied included age, criminal record, community status, and credit standing. About five percent of the driver population is causing 30 percent of the traffic accidents and deaths. The alcohol aspects were not part of the study but considered as the largest single factor involved in traffic deaths. The point system, law enforcement, loss of license, and license appeals are discussed. More severe penalties and better enforcement are needed.

Search terms: Problem drivers; Penalties; Drinking drivers; Driver behavior; Point systems; Michigan; Credit ratings; Driver criminal history; Traffic law enforcement; Traffic law violators; Driver license revocation; Driving without a license; Driver intoxication; Sociological factors; Young adult drivers; Age factor in accidents; Driver records

### HS-009 946 Fld. 3/4; 3/12

#### VISIBILITY AND DRIVING. PROCEEDINGS OF THE 2ND ANNUAL SYMPOSIUM, BERKELEY, CALIFORNIA, JULY 8-10, 1969

**3/4 Driver Behavior (Cont'd.)****HS-009 946 (Cont'd.)**

California Univ. ITTE

Dec 1969 104p

Includes HS-009 932, 009 934-009 936, 009 943, 009 951, 009 953, 009 980-009 982.

Ten papers are presented covering various aspects of driving visibility and vision as they relate to fog, fog dispersal, fog warning systems, street lighting, vehicle lighting, and vision tests for drivers. Four summaries of workshops on driver visibility tests, vehicle lighting, fog, and roadway lighting are also included.

Search terms: Fog driving; Fog dispersal; Reduced visibility; Weather caused accidents; Fog warning systems; Fog; Highway lighting; Driving conditions; Night visibility; Vehicle lighting; Vision tests; Driver licensing

**3/5 Driver Education****HS-009 947 Fld. 3/5****A DESCRIPTION OF THE DRIVING TASK ADAPTABLE FOR A MANUAL FOR BEGINNING DRIVERS**

by James L. Malfetti

Columbia Univ.

970 156p 591 refs

Sponsored by Insurance Inst. for Highway Safety.

This monograph describes driving and the forces which relate to skillful and safe performance in a way most useful for those who write manuals for beginning drivers, especially state motor vehicle administrators. Emphasis is placed on these aspects of driving known to be associated with violations, accidents, injuries, and traffic flow. The role of the driver as one element in a traffic system is discussed with emphasis

on what he can do as a driver to improve efficiency and safety. Description of the driving task is divided into four parts: the task and skills needed to perform it; general performance skills; common driving maneuvers; selected conditions of highway, weather, vehicle, and driver which influence the driving task.

Search terms: Driver education-manuals; Driver education; Driver experience; Driving task analysis; Bibliographies; Driver skills; Driver vehicle interface; Environmental factors; Highway characteristics; Vehicle control; Driver performance

**3/6 Driver Licensing****HS-009 948 Fld. 3/6; 3/9****REVISED BMCS REGS POINT UP DRIVER IMPORTANCE**

by Robert A. Kaye

Published in *Traffic Safety* v71 n5 p12-4 (May 1971)

With the help of industry, the Bureau of Motor Carrier Safety in the U. S. Department of Transportation developed new rules for qualifications of commercial drivers, effective January 1, 1971. Too many accidents were attributed to unqualified or irresponsible drivers. For instance, in 1969, of 286 accidents with heavy commercial vehicles, 16 percent involved unfit or unqualified drivers. The new rules include driving records, medical examinations, in-service records and performance monitoring on the job, determination of unfitness to continue driving, use or possession of alcoholic beverages and drugs. Labor, management, insurance companies, and government recognize the importance of the human element to commercial-carrier safety.

Search terms: Professional drivers; Commercial vehicles; Motor carriers; Driver physical fitness; Driver mental fitness; Driver records; Truck drivers; Fleet safety; Driver physical examinations; Drinking drivers; Drugs; Driver error caused accidents

**3/7 Drugs Other Than Alcohol****HS-009 949 Fld. 3/7; 3/1****DRUGS AND HIGHWAY CRASHES—CAN WE SEPARATE FACT FROM FANCY?**

by Julian A. Waller

Published in *Journal of the American Medical Association* v215 n9 p1477-82 (1 Mar 1971)

24 refs

Presented to Plenary Session on Drugs and Alcohol in Relation to Traffic Safety at the 29th International Congress on Alcohol and Drug Dependence, Sydney, Australia, 6 Feb 1970.

This paper examines the extent to which impairment by mind-altering drugs other than alcohol is a factor in highway crashes, and seeks to identify the types of persons likely to get into trouble on the highway as a result. The extent to which the drug and alcohol problems overlap is also investigated. Data available indicate some crashes are attributable to impairment from drug effects. Except for amphetamine abuse, drug effects are not very marked, and usually occur when users are not exposed to the hazards of walking or driving. Two categories of users who represent a problem, but not because of drugs, are sociopaths who repeatedly flaunt authority in a variety of ways, and problem drinkers. A third group who use prescription or non-prescription drugs to cope with every day stresses and young adults who use only marijuana probably do not have an increased risk of crashes or citations.

Search terms: Drug caused accidents; Driver physical fitness; Driver mental fitness; Marijuana; Amphetamines; Accident rates; Hallucinogens; Drinking drivers; Alcoholism; Drug effects; Drug addiction; Psychopaths

OCTOBER 22, 1971

## HUMAN FACTORS

### 3/8 Environmental Effects

HS-009 950 Fld. 3/8

#### VARIATION IN MEASURED AUTOMOBILE PASSBY NOISE DUE TO OPERATOR AND ENVIRONMENTAL FACTORS

by Robert M. La Breche

General Motors Proving Ground

n.d. 6p

Report no. GM-Eng-Pub-4587

The State of California has enacted legislation prohibiting the sale of new automobiles which produce maximum passby noise of 86 dB(A). Using the procedure of the California Highway Patrol—patterned after SAE J986a—General Motors conducted a series of tests at three different sites and at various times and determined that ambient temperature, wind, test location, and operators can produce systematic errors in excess of the 2dB tolerance allowed by the present California code. Further study of these factors is needed in establishing tolerance allowed by the present California code. Further study of these factors is needed in establishing tolerance limits for noise measuring standards.

Search terms: Noise standards; Vehicle noise; Acoustic measurement; Environmental factors; Wind; Ambient temperatures; Errors

HS-009 951 Fld. 3/8; 2/7; 1/3

#### FOG, DRIVERS' REACTION AND ACCIDENTS IN CALIFORNIA

by David J. Theobald

California Div. of Highways

Published in HS-009 946, *Visibility and Driving*, Berkeley, 1969, p18-22

Presented at 2nd annual Symposium on Visibility and Driving, Berkeley, 8-10 Jul 1969.

An investigation into multiple-vehicle fog accidents showed that reduced visibility rendered normal stopping distance allowances insufficient to be safe; drivers simply drive faster than the safe speed under most fog conditions. Drivers slowed about 5 mph for fog and another 5 mph when a brightly illuminated sign displayed a speed limit they believed reasonable. Increased presence of California Highway Patrol units had the effect of reducing speeds 4-6 mph under some conditions, but no effect in others.

Search terms: Fog; Reduced visibility; Multiple vehicle accidents; Driving conditions; Driver performance under stress; Weather caused accidents; Fog driving; California; Fog warning systems

### 3/12 Vision

HS-009 952 Fld. 3/12

#### SAFETY LENSES ARE A DRIVING PLUS

by Harris Edward Dark

Published in *Traffic Safety* v71 n6 p22-3, 33 (Jun 1971)

Only 25% of the prescription eye glasses now being sold are classified as protective. It seems that the general public is not aware of the threat posed by breakable glasses, nor of the fact that shatter-resistant glasses are easily obtainable, not expensive, and can also prevent injury from missiles that could cause serious eye damage. Another eyeglass danger that should receive publicity is the fact that some spectacle frames are made of materials that can catch on fire or explode. Until federal legislation is passed, it is up to the individual to take the initiative when purchasing new glasses. A vigorous educational effort is needed to alert the general public to these dangers.

Search terms: Eyeglasses; Eye protection; Eye injuries; Glass caused injuries; Fire resistant materials; Flying objects

HS-009 953 Fld. 3/12

#### VISUAL TESTING FOR DRIVER LICENSING—U.S. PRACTICE

by Paul L. Connolly

Published in HS-009 946, *Visibility and Driving*, Berkeley, 1969 p77-93

20 refs

Presented at 2nd annual Symposium on Visibility and Driving, Berkeley, 8-10 Jul 1969.

Visual requirements for driver licensing must consider the total performance capabilities of the motor vehicle operator and should not be based exclusively upon specific non-driving performance tasks where all of the parameters of the situation are defined and are constant, such as the visual performance required to read Snellen letters on a visual acuity chart in a controlled clinical environment. All indications today seem to point to an interprofessional, interdisciplinary approach to the evaluation of the visual capability of the driver who cannot meet minimum vision screening standards for licensure which have been or will be established. Accompanying this evaluation must certainly be the actual performance of the applicant behind the wheel under a representative number of driving environments which he might encounter, particularly those environments where his visual capability may be near the limits of safe performance.

Search terms: Driver licensing; Vision tests; Vision; Vision age changes; Vision disorders; Visual acuity; Depth perception; Visual fields; Highway signs; History; Driver tests

HS-009 954 Fld. 3/12; 3/4

#### DRIVERS' EYE MOVEMENTS AND VISUAL WORKLOAD

by R. R. Mourant; T. H. Rockwell; N. J. Rackoff

Published in *Highway Research Record* n292 p1-10 (1969)

## OTHER SAFETY RELATED AREAS

HSL No. 71-27

### 3/12 Vision (Cont'd.)

#### HS-009 954 (Cont'd.)

5 refs

Sponsored by HRB Committee on Road User Characteristics and presented at the 48th annual meeting.

An eye-marker camera was used to record drivers' visual search and scan patterns under three levels of route familiarity and two driving conditions, open-road driving and steady-state car following. The results showed that for open driving the visual patterns shifted to the left and down and showed more compactness as familiarity with the route increased. For car following, the increase in compactness of the visual pattern with route familiarity was pronounced but there was no change in the center of location of the visual pattern. Compared with open driving, the travel distances for car following were greater when looking ahead and at bridges, road signs, and other vehicles. However, drivers in the car-following condition spent less time reading road signs, indicating that they used the lead car as an aid for route guidance. Possible visual aids for decreasing the driver's visual workload under today's driving conditions are discussed.

Search terms: Eye movements; Car following; Driving tasks; Driver performance; Visual perception; Visual behavior; Driver route familiarity

## 4/0 OTHER SAFETY-RELATED AREAS

### 4/1 Codes and Laws

#### HS-009 955 Fld. 4/1; 3/6

### PARENTAL CONSENT

National Com. on Uniform Traf. Laws and Ordinances

Published in *Traffic Laws Commentary* n71-4 p1-12 (30 Jul 1971)

refs

This commentary reviews state laws comparable to Uniform Vehicle Code provisions which would require parental consent to the issuance of a driver's license to certain minors. The Uniform Vehicle Code requires continuing parental consent to the licensing of minors under the age of 18, and, unless proof of financial responsibility is deposited on behalf of the minor, imputes the responsibility for any damage caused by the minor to the consenting parent. Subjects reviewed and discussed are: who is to consent—how consent is to be given—which licenses are covered—which *licensees* are covered—withdrawal of consent; nature of parental liability—avoiding parental liability—terminating parental liability. Citations to state laws are included.

Search terms: Driver license laws; Legal responsibility; Liability; Uniform Vehicle Code; Law uniformity; State laws; Parents; Adolescent drivers; Financial responsibility; Driver license cancellation

### 4/3 Cost Effectiveness

#### HS-009 956 Fld. 4/3 2/4

### RUNNING COSTS OF MOTOR VEHICLES AS AFFECTED BY ROAD DESIGN AND TRAFFIC

by Paul J. Clafsey

Clafsey (Paul J.) and Associates; Catholic Univ. of America

1971 109p 119 refs

Report no. NCHRP-111

Research sponsored by American Association of State Highway Officials in cooperation with Federal Highway Administration.

This report is intended to give information on the running costs of cars and trucks that may readily be applied to the economic analysis of highway improvements by highway planners, economists, traffic engineers, and design engineers. Reliable running costs, based on field tests of motor vehicles, are presented as broken down into the cost categories of

fuel, oil, tire wear, maintenance, depreciation, and accident costs. Relationships between the cost categories and highway grades, operating speeds, roadway surface, horizontal alignment, and traffic volumes are provided to facilitate the calculation of automobile and truck fuel and the tire costs for free-flowing volumes. Included in this report are detailed examples illustrating typical problems that can be solved by use of the information presented. Annotated bibliographies are included on the subject of motor vehicle operating costs and on relationships between highway accident costs and highway design.

Search terms: Vehicle operating costs; Fuel consumption; Tire wear measurement; Depreciation; Automobile maintenance; Truck maintenance; Accident costs; Oil consumption; Highway design; Road surfaces; Traffic volume; Highway improvements; Economic analysis; Benefit cost analysis; Speed; Road grades; Traffic characteristics; Field tests; Mathematical models

AVAILABILITY: HRB \$5.20

### 4/7 Mathematical Sciences

#### HS-009 957 Fld. 4/7; 1/4

### CROSS-MEDIAN CRASHES

by Paul H. Wright; John S. Hassell, Jr.; Bert Arrillaga

Published in *Highway Research Record* n332 p44-53 (1970)

2 refs

Presented at the Highway Research Board 49th annual meeting.

Although cross-median collisions tend to be severe, their rarity makes empirical study difficult. A computer simulation model was developed that described a 4-lane expressway in which cars were randomly released to cross the median at a right angle and at a constant speed. No provision was made for the driver to

brake or regain control of the car. Opposing vehicles were generated by the negative exponential distribution. The effects of the following variables on probability of crash and average impact speed were studied; lane volume, speed of opposing vehicles, speed of crossing vehicles, median width, perception and reaction time, and skid resistance. It was found that, for those vehicles crossing the median, the probability of a crash was significantly increased by increase in lane volume, decrease in median width, decrease in vehicle speeds, and increase in reaction time. Skid resistance was of least importance in reducing crash probabilities. Average impact speed was significantly increased by increase in vehicle speeds, increase in reaction time, and decrease in median width.

Search terms: Traffic volume; Median with; Median encroachments; Median crossover collisions; Impact velocity; Variables; Oncoming vehicles; Accident simulation; Ran off road accidents; Head on collisions; Mathematical models; Computerized simulation; Simulation models; Speed patterns; Accident risk forecasting; Driver reaction time; Skid resistance

## 5/0 VEHICLE SAFETY

### 5/1 Brake Systems

#### HS-009 958 Fld. 5/1

#### HEAVY DUTY BRAKE DRUMS

by Jack Lyndall

Published in *Fleet Owner* v66 n2 p60-6, 176 (Feb 1971)

The basic characteristics of the ideal brake drum for heavy duty vehicles are described. Factors that contribute to brake drum wear are explained.

Search terms: Brake drums; Brake drum materials; Brake drum properties; Heavy duty vehicles; Brake drum wear

#### HS-009 959 Fld. 5/1

#### IMPACT OF PROPOSED GOVERNMENT STANDARDS ON PASSENGER CAR BRAKE SYSTEM DESIGN

by G. B. Hickner; J. L. Turak

Bendix Corp.

1971 10p 3 refs  
Report no. SAE-710592

Presented at the SAE International Mid-Year Meeting, Montreal, 7-11 Jun 1971.

The Department of Transportation has proposed a new set of performance standards for passenger car brake systems. The impact of these requirements has been investigated analytically and experimentally. The results of these studies are presented. It is concluded that modifications are necessary to most of today's brake systems to meet these difficult standards.

Search terms: Brake system design; Brake standards; Stopping distances; Braking distances; Brake torque; Deceleration tests; Brake fade; Federal control; Vehicle weight; Brake performance

AVAILABILITY: SAE

#### HS-009 960 Fld. 5/1

#### ALL STEEL BRAKE DISC DEVELOPMENT

by R. H. VanSteenkiste; E. K. Buyze

1971 12p  
Report no. SAE-710590

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

The design, development, and manufacture of a steel brake disc for an automotive brake are discussed. The steel disc must retain all the qualities of a cast iron disc, and must be competitively priced. Production techniques and design for steel brake

rings and corrugated drivers are dealt with. Electron beam welding was employed, and the process used is explained. Tests and test results of the all steel disc are outlined. The advantages of the all steel disc are: compatibility with currently available manufacturing processes; less material removed for finishing of brake rings; uniformity of parts rendering balancing unnecessary; greater strength, less weight than cast iron disc; interchangeability with cast iron disc; no sacrifice in lining or disc wear; improvement in brake performance and fade test characteristics; and better cooling characteristics.

Search terms: Disc brakes; Brake discs; Steels; Brake disc materials; Brake disc production; Brake tests; Brake performance; Electron beam welding; Brake rings

AVAILABILITY: SAE

#### 5/2 Buses, School Buses, and Multipurpose Passenger Vehicles

#### HS-009 961 Fld. 5/2; 1/3

#### SAFETY BUS INSPECTION PROGRAM. MOTOR CARRIERS OF PASSENGERS. ANNUAL REPORT, CALENDAR YEAR 1970

Bureau of Motor Carrier Safety.

Apr 1971 26p

In 1970, following a number of severe interstate bus accidents, the Bureau of Motor Carrier Safety sharply increased its bus inspection activity. During the year 5,902 buses were inspected, each covered by an individual report. The vehicles inspected were an unselected sample of interstate buses throughout the country. Buses taken out of service on the spot were 11.6% of the total. These buses were less well maintained and tended to have a multiplicity of defects in addition to the incapacitating defects. Chartered buses usually had more defects per bus than did scheduled vehicles, although chartered carriers had

**5/2 Buses, School Buses, etc.  
(Cont'd.)****HS-009 961 (Cont'd.)**

a higher percentage of defect-free vehicles than scheduled carriers. Large numbers of defects were reported in the system for the application of service brakes. Results of the inspections are tabulated by type of operation and kind of defect for each field regime of the Federal Highway Administration.

Search terms: Buses; Bus defects; Bus inspection; Defective vehicles

**5/4 Design****HS-009 962 Fld. 5/4****NEW CRITERIA FOR AIR CONDITIONING BELT DRIVE DESIGN**

by Ashok K. Goyal; Allen J. Bentley

Ford Motor Co.

1971 9p 3 refs  
Report no. SAE-710546

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Belt drives are simple and efficient and are widely used, but they are often a source of vibration and noise. Usually, in the case of the automobile engine accessory drive system, especially air conditioning drive, considerable development time is spent on reducing this noise and vibration to an acceptable level. Herein, an analytical method is presented which allows the designer to approach this objective in the initial design stages. It is shown that a number of variables such as torque characteristics, belt span, belt material and construction contribute to the objectionable noise.

Search terms: Air conditioner belts; Vibration; Noise; Mathematical analysis; Air compressors; Belt drive design; Torque; Equations

AVAILABILITY: SAE

**HS-009 963 Fld. 5/4****MANUFACTURING THE NEW INTERNATIONAL HARVESTER 300-400 SERIES DIESEL ENGINES**

by George R. DePrima; Robert J. Klein

International Harvester Co.

1971 29p  
Report no. SAE-710556

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A new series of heavy duty diesel engines has been put into production by the Construction Equipment Division of the International Harvester Company. The new engines, known as the 300-400 series, displace a number of older IH units. The engines have been toolled for commonality of parts and for economical high volume production. This paper deals with some aspects of the tooling, fabrication, assembly, and production testing of the engines. The crankcase, cylinder heads, cylinder sleeves, crankshaft, camshaft, connecting rods, and flywheels are discussed in detail.

Search terms: Diesel engines; Crankcases; Cylinders; Crankshafts; Rods; Camshafts; Engine Tests; Cylinder heads; Flywheels

AVAILABILITY: SAE

**HS-009 964 Fld. 5/4****BUMPERS. A BILLION-DOLLAR "BUST"**

by Joe P. Faulkner

Published in *Journal of Insurance* v31 n5 p26-31 (Sep-Oct 1970)

Lack of protection afforded by the bumpers on today's automobiles, the damage resulting from low-speed accidents, and the high cost of repairs are discussed. A table of crash test results shows the estimated cost to repair twelve popular car models for seven

different types of collisions, all at speeds of 15 mph or less. Design of an effective bumper could substantially reduce the cost of accidents and consequently the amount paid out in insurance claims. Energy absorbing bumper designs, including water bumpers, are discussed.

Search terms: Insurance claims; Bumper design; Water bumpers; Damage costs; Automobile repair costs; Energy absorbing bumpers

**HS-009 965 Fld. 5/4****FEDERAL SAFETY SPECIFICATIONS FOR AUTOMOBILES, TRUCKS, AND BUSES**

by Horace E. Campbell

Published in *Nebraska State Medical Journal* p510-5 (Sep 1962)

25 refs

Presented at annual convention, Nebraska State Medical Assoc., May 1962.

This article lays much of the blame for the high toll of deaths and injuries on faulty design and construction of the automobile. A case is made for designing the car interior to eliminate unnecessary protrusions and installing crash padding. Seat belts, shoulder harnesses, and hydraulic bumpers are also cited as features that can reduce the incidence of death and injury in an accident. Encouragement for the car manufacturers to install such devices must come through safety legislation at the federal level. The forces of deceleration and the role of alcohol in fatal accidents are also discussed.

Search terms: Safety standards; Automobile design; Safety design; Padding; Occupant protection; Crash-worthiness; Interior design; Bumper standards; Restraint systems; Fatalities; Drinking drivers; Deceleration

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## VEHICLE SAFETY

### HS-009 966 Fld. 5/4

#### THE BATTLE OF THE BUMPERS

by Walter Mossberg

Published in *Traffic Safety* v71 n5 p27, 36-7 (May 1971)

New bumper designs to protect against low-speed crashes pose problems for the manufacturers. Cost per car will probably increase \$50 or more, and really effective bumpers must extend a few inches. Cars will be a tight fit in existing garages, and appearance will hardly be as sleek as the ineffective bumpers of recent years. Over manufacturers' protests, insurance companies and legislators are demanding more protection. The automotive industry proposes using the new bumpers only on the front of vehicles.

Search terms: Energy absorbing bumpers; Bumper standards; Automobile repair costs; Crashworthiness; Bumper design; Vehicle length; Impact tolerances

### HS-009 967 Fld. 5/4

#### HOW FRACTURE MECHANICS CAN HELP THE DESIGNER

by E. J. Ripling; J. E. O'Donnell

Materials Res. Lab., Inc.

1971 13p 20 refs  
Report no. SAE-710153

Presented at Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

The present status of fracture mechanics relative to the need of vehicle designers is discussed. Examples are given of the application of this discipline to the design of structures subjected to either a single load or fatigue loading. For the latter, both finite life and infinite life designs are considered.

Search terms: Fracture mechanics; Failure stress; Loads (forces); Materials

test; Strain (mechanics); Stress (mechanics); Fatigue (materials); Vehicle design; Service life

AVAILABILITY: SAE

### HS-009 968 Fld. 5/4; 4/7

#### USE OF COLLAPSIBLE STRUCTURAL ELEMENTS AS IMPACT ISOLATORS, WITH SPECIAL REFERENCE TO AUTOMOTIVE APPLICATIONS. PART 1. DEVELOPMENT OF AN IMPACT ANALYSIS FOR STRUTS

by H. E. Postlethwaite; B. Mills

Published in *Journal of Strain Analysis* v5 n1 p58-64 (1970)

Simple struts have been impacted between travelling the stationary masses and the collapse found to consist of two distinct phases. The pre-failure phase, being primarily an elastic region, has been analyzed by stability criteria and the post-failure phase by consideration of the plastic collapse of the strut. Associated with the pre-failure phase is a large transient deceleration which is found, among other parameters, to be a function of the strut shape.

Search terms: Impact attenuators; Stress (mechanics); Struts; Failure stress; Breaking energy; Deceleration; Mathematical analysis; Energy absorption; Impact forces; Equations of motion; Impact tolerances

### HS-009 969 Fld. 5/4; 4/7

#### USE OF COLLAPSIBLE STRUCTURAL ELEMENTS AS IMPACT ISOLATORS [WITH SPECIAL REFERENCE TO] AUTOMOTIVE APPLICATIONS. PART 2. IMPACT ANALYSIS OF SHEET-METAL STRUCTURES

by H. E. Postlethwaite; B. Mills

Published in *Journal of Strain Analysis* v5 n1 p65-73 (1970)

15 refs

A series of sheet-metal structures have been impacted and, like struts, the collapse found to consist of pre- and post-failure phases of separate identities. The pre-failure phase is again associated with the shape of the structure and may give rise to a large transient deceleration. This analysis has led to the consideration of more complex elements, such as might be found in an automobile frontal structure, and finally to a complete automobile analogue. Conclusions are drawn about the structural parameters required to bring about specific deceleration characteristics in a vehicle crash.

Search terms: Impact attenuators; Crashworthiness; Energy absorbing front structures; Impact forces; Sheet metal; Mathematical analysis; Deceleration; Failure stress; Energy absorption; Tubes; Impact tolerances

### HS-009 970 Fld. 5/4; 5/14

#### WHAT DO THE EXPERTS THINK?

by Len Barnes

Published in *Motor News* v53 n11 p18-21 (May 1971)

Twenty-five auto writers responding to a questionnaire were outspoken about the industry. Samples were: best developments in the '71 cars are trend to smaller, simpler machines, easier servicing, adaptation to lead-free gas; safety improvements are few since styling still sells cars; safety could sell cars if ads pushed it; air bags are not wanted even if offered free (several writers felt more development of these restraints needed); seat belts are liked, but not shoulder harnesses or head restraints; 18 writers felt companies are not doing all they can on safety; greatest industry problems in next 10 years are pollution, safety, costs and sales against overseas competition.

Search terms: Automobile design; Automobile models; Consumer preferences; Safety design; Opinion polls; Automobile safety characteristics

**HS-009 971 Fld. 5/4; 5/18; 5/6**

**P A S S E N G E R C A R  
D R I V E A B I L I T Y I N C O O L  
W E A T H E R**

by J. D. Benson; H. A. Bigley, Jr.; J. L. Keller

Coordinating Res. Council

1971 20p 7 refs  
Report no. SAE-710138

Presented at Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

During March 1969, a test program was conducted at Pasco, Wash., to investigate a driveability test procedure and the effects of fuel volatility on driveability during cool weather (30-50°F). Fifteen late-model automobiles and eight fuels with different volatility characteristics were evaluated. Driveability was rated subjectively during cold-start and drive-away, and after the car had warmed-up. For the cold phase, driveability was related to fuel volatility as defined by the front-end and mid-boiling range of the fuel distillation curves. However, driveability during the warm phase was not affected by fuel volatility within the range of fuels tested.

Search terms: Driveability; Performance characteristics; Coldstarts; Cold weather tests; Fuel volatility; Performance tests

AVAILABILITY: SAE

**5/5 Door Systems**

**HS-009 972 Fld. 5/5**

**C O M P A R I S O N O F D O O R O P E N I N G F R E Q U E N C Y I N 1967-1968  
A M E R I C A N M O T O R S C O R P O R A T I O N C A R S W I T H E A R L I E R  
M O D E L C A R S**

by Roger B. Fargo

Cornell Aeronautical Lab., Inc. ACIR

Sep 1970 8p 7 refs  
Report no. ACIR-Bull-10

Earlier studies identified automobile door opening and associated occupant ejection as markedly increasing the risk of serious injury or death. The frequency of door opening in 1964, 1965-66, and 1967-68 American Motors car models is examined and compared with that shown for 1962-63 American Motors models. The data may be compared with data on door opening frequency for other American vehicles. Data indicated that there has been a progressive decrease in the frequency of door opening since the 1955 models.

Search terms: Door system failures; Door latch failures; Automobile models; Automobile comparisons; Door hinge failures

**5/6 Fuel Systems**

**HS-009 973 Fld. 5/6**

**N E W : A C A T A L Y T I C  
C O N V E R T E R T H A T R E A L L Y  
C L E A N S U P A U T O E X H A U S T**

by Joseph P. Zmuda

Published in *Popular Science* v197 n6 p47-9 (Dec 1970)

Automakers expect the price of a catalyst system to be as much as ten percent of the price of the car. Universal Oil Products (UOP) claims they have developed a system that can transform 90% of three major pollutants without affecting mileage or performance, last the life of the car, and cost \$35 to \$70, depending on size. The chemical composition of the UOP catalyst is a proprietary secret; however, it is known that the catalyst can withstand temperatures of 2,000°. The UOP system can achieve both oxidation and reduction with that single catalyst. The UOP catalytic converter is made in four different shapes so that it can fit any type of car running on lead free gasoline.

Search terms: Catalytic converters; Catalysts; Lead free gasoline; Exhaust emission control devices; Nitrogen oxides; Hydrocarbons; Carbon monoxide; Automobile costs

**HS-009 974 Fld. 5/6**

**R O A D A N T I K N O C K P E R F O R M A N C E O F L O W - L E A D A N D  
N O N L E A D E D G A S O L I N E S I N  
E U R O P E A N C A R S**

by A. G. Bell; J. A. Keene; K. Reders

Shell Res. Ltd. (England); Deutsche Shell A.G. (West Germany)

1971 28p 6 refs  
Report no. SAE-710625

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

An experiment designed to evaluate the road antiknock performance of low-lead and nonleaded gasolines is described. Over 100 test fuels covering a wide range of research octane number, lead content, sensitivity, and front-end quality were prepared. They were then tested in both accelerating and wide-open-throttle constant-speed conditions. The design of the experiment and the analysis and interpretation of the results are given. It is concluded that, in general, in European cars knocking at low speed, road antiknock performance can be adequately described in terms of research octane number, sensitivity, and front-end quality, and that there is no additional benefit to be gained from the use of a high concentration of lead. By contrast, in European cars knocking at high speed, and in the one American car tested, gasolines with a high lead content gave a better performance than the equivalent nonleaded gasolines. This was particularly so in the case of fuels leaded with tetramethyl lead as opposed to tetraethyl lead.

Search terms: Tetraethyl lead; Tetraethyl lead; Fuel additives; Lead free gasoline; Octane requirements; European vehicles; Leaded gasoline; Knock; Performance tests; Gasoline

AVAILABILITY: SAE

**HS-009 975 Fld. 5/6**

**E M I S S I O N O P T I M I Z A T I O N O F  
H E A T E N G I N E / E L E C T R I C V E-  
H I C L E**

by Jerar Andon; I. R. Barpal

Minicars, Inc.

28 Jan 1971 94p 7 refs  
Report no. PB-198 093

Prepared for Air Pollution Control Office, Environmental Protection Agency.

A study was made to determine the relative reduction in exhaust emissions obtainable from a heat engine/electric hybrid vehicle when compared to the same vehicle powered by a heat engine alone. The hybrid vehicle was powered by a nominal 20 hp DC electric motor and an internal combustion engine of approximately 40 hp rating. The emission evaluations were made with the vehicle in three design phases: vehicle in original hybrid design; electrical power increased and a delay throttle control installed; and vehicle engine manifold revised to burn leaner air/fuel mixtures. Tests of the hybrid designs indicated a marked reduction of exhaust emissions with the delayed throttle control and increased electrical power. The heated manifold allowed leaner air/fuel mixtures to be used and resulted in lower exhaust emissions. Emissions of hydrocarbons, carbon monoxide, and nitrogen oxides in the tests are discussed.

Search terms: Intake manifolds; Hybrid vehicles; Power trains; Internal combustion engines; Ignition timing; Exhaust emission tests; Air fuel ratio; Lean fuel mixtures; Laboratory tests; Engine operating conditions; Hybrid engines; Hydrocarbons; Carbon monoxide; Nitrogen oxides; Throttles; Vehicle weight

AVAILABILITY: NTIS

#### HS-009 976 Fld. 5/6

#### CHANGES IN VALVE TIMING CAN REDUCE EXHAUST EMISSIONS

by Robert M. Siewert

Published in *Automotive Engineering* v79 n6 p40-4 (Jun 1971)

Prepared for presentation at SAE International Mid-Year Meeting, Montreal, 10 Jun 1971.

Advancing the intake valve opening or exhaust valve closing time significantly reduced hydrocarbon and nitrogen oxide emissions under partial-load, low-speed operation. One cylinder of a 400 cu. in. V-8 engine typical of current production engines was used in the tests. Emission reductions are explained as due to internal recirculation. Fuel consumption and CO emissions were unaffected.

Search terms: Valve timing; Exhaust emission control; Exhaust emission tests; Exhaust gas recirculation; Air pollution emission factors; Hydrocarbons; Carbon monoxide; Nitrogen oxides; Fuel consumption; Exhaust valves; Single cylinder engines; Exhaust gases; Intake valves

#### HS-009 977 Fld. 5/6

#### EFFECTS OF MIXTURE DISTRIBUTION ON EXHAUST EMISSIONS AS INDICATED BY ENGINE DATA AND THE HYDRAULIC ANALOGY

by D.R. Liimatta; R.F. Hurt; R.W. Deller; W.L. Hull

Ethyl Corp; Bradley Univ; Illinois Univ.

1971 35p 13 refs  
Report no. SAE-710618

Prepared for presentation at the SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A new method of studying the mixing conditions that take place in a fuel induction system is discussed. This method involves the use of a conventional water table to pictorially demonstrate the salient flow field characteristics and mixing patterns that were encountered at typical engine operating conditions. Also, several different geometric configurations and their resultant flow patterns are included. Some of these configurations were duplicated in an experimental induction system and were shown to have similar flow field patterns. Engine data are presented which indicate how the three major automotive exhaust pollutants are affected by the distribution of the induced fuel. Nonuniform fuel distribu-

tion prohibits lean engine operation without increasing hydrocarbon emissions. Nitrogen oxide emissions are lower at a given fuel-to-air ratio with non-uniform fuel distribution, this condition being particularly true near stoichiometric conditions. Carbon monoxide emissions are lower with more uniform fuel distribution.

Search terms: Lean fuel mixtures; Exhaust emission tests; Exhaust composition; Carbon monoxide; Hydrocarbons; Air fuel ratio; Nitrogen oxides; Throttling; Fuel induction; Fuel flow; Simulation

AVAILABILITY: SAE

#### HS-009 978 Fld. 5/6

#### THE DRIVE FOR CLEAN AIR. A STATUS REPORT ON THE CONTROL OF AIR POLLUTION ON OUR HIGHWAYS

by Virginia Wayland

Published in *Highway User* p8-12, 39 (May 1971)

Widespread concern about air pollution is only a few years old. Considerable progress has been made in reducing automotive emissions, although they may be only about 10 percent of total air pollutants in this country. Hydrocarbon emissions on current models are only 20 percent of those for 1960 models, but 90 percent further reduction by 1980 may be achieved. Environmental Protection Agency has required all states to have pollution control plans in effect by 1975. The smog problem in California, the Inter Industry Emission Control Program, and exhaust emission control devices are discussed.

Search terms: Air pollution control agencies; Air pollution control; Exhaust emissions; Exhaust emission standards; Hydrocarbons; Carbon monoxide; Sulfur oxides; Nitrogen oxides; Air pollution emission factors; Vehicle air pollution; Smog; California; Inter Industry Emission Control Program; Exhaust emission control devices

HS-009 979 Fld. 5/6; 4/7

**MATH MODELING OF AN EXHAUST REACTOR**

by M. H. Blenk; R. G. E. Franks

DuPont de Nemours (E. I.) and Co.

1971 42p 15 refs  
Report no. SAE-710607Presented at SAE mid-year meeting,  
Montreal, 7-11 Jun 1971.

Thermal and chemical processes occurring in exhaust manifold thermal reactors have been closely simulated with a computer model. The model has been developed to predict the performance of thermal reactors operating on multicylinder engines in vehicle service. Output predictions include both transient and steady-state response including reactor warmup at steady-state engine operation. Gas and metal temperatures, heat fluxes, and concentrations of selected exhaust components can be followed as a function of time at various locations within the reactor. Effects of imperfect mixing of exhaust gases with auxiliary air, optimum secondary air injection rates for minimum carbon monoxide survival under various operating conditions, and transient reactor response to a misfire condition were studied. Development of the principles used in formulating the model, including both thermal and chemical considerations, are treated in detail.

Search terms: Mathematical models; Computerized simulation; Exhaust manifold reactors; Chemical reactions; Thermal reactors; Data acquisition; Engine operating conditions; Steady state; Exhaust emission control; Exhaust gases; Air injection reactor systems; Fortran; Heat transfer

AVAILABILITY: SAE

**5/10 Lighting Systems**

HS-009 980 Fld. 5/10

**MODERN TRENDS IN HEADLIGHTING**

by G. D. Lawson

Sylvania Electric Products, Inc.

Published in HS-009 946, *Visibility and Driving*, Berkeley, 1969 p47-50

Presented at 2nd annual Symposium on Visibility and Driving, Berkeley, 8-10 Jul 1969.

The quartz (tungsten-halogen) lamp which is fast gaining acceptance in the United States is described. This lamp, which retains 97% of its initial brightness throughout its lifetime, does not blacken with use, has a whiter, more natural light, and is no larger than a man's thumb. Quartz bulbs are already used for headlights in Europe and they offer much improved headlight beam pattern, taking the best from both Europe and the United States, to provide better highway illumination. Various types of auxiliary lights are mentioned.

Search terms: Quartz halogen tungsten headlamps; Brightness; Headlamp aiming; High beamed headlamps; Low beamed headlamps; Headlamp glare; Auxiliary lamps; European vehicles

HS-009 981 Fld. 5/10

**HEADLAMP BEAM USAGE ON U.S. HIGHWAYS**

by Charles T. Hare; Roger H. Hemion

Southwest Res. Inst.

Published in HS-009 946, *Visibility and Driving*, Berkeley, 1969 p51-71

7 refs

Presented at 2nd annual Symposium on Visibility and Driving, Berkeley, 8-10 Jul 1969.

Headlamp beam usage by drivers at eighteen locations in fifteen states in the continental United States was analyzed in a study conducted for the Bureau of Public Roads. Results showed: headlamp beam usage was highly dependent on the traffic situation; most drivers who dimmed their lamps for oncoming vehicles did so at long intercar distances, over 60% of the vehicles were travelling at unsafe speeds; usage of lamps was independent of topography but slightly affected by weather conditions; use of low beam in presence of street lighting indicated most drivers felt this lighting gave better visibility than that available from automobile headlamps; area-to-area differences in beam usage appear to be the result of different conditioning processes, as yet unidentified.

Search terms: High beamed headlamps; Low beamed headlamps; Night visibility; Highway lighting; Night driving; Headlamp glare; Highway characteristics; Driving conditions; Topographical factors; Speed; Weather; Headlamp usage

HS-009 982 Fld. 5/10

**PROGRESS IN VEHICLE REAR LIGHTING RESEARCH**

by Vincent J. Esposito, Jr.; Robert Knaff

National Hwy. Safety Bureau

Published in HS-009 946, *Visibility and Driving*, Berkeley, 1969 p72-6

6 refs

Presented at 2nd annual Symposium on Visibility and Driving, Berkeley, 8-10 Jul 1969.

The National Highway Safety Bureau's research program on vehicle rear lighting is reviewed. It has been determined that any system employing more than the single fixture or lamp on each side will give better driver performance, but no clear cut conclusion has been reached as to which multifixture system is superior. The safety performance of rear lights

would be improved if the various messages were separated in at least two dimensions: for instance, intensity and physical location. Maximum and minimum intensities and the desirability of multi-level intensities for rear lights are discussed. The mounting height standard of 15 in. for rear lights is agreed to be too low, and some preferable placements of various rear signals are mentioned. Future research is deemed to be desirable in such fields as additional information displays and methods of transmitting information from driver to driver.

Search terms: Vehicle lighting; Rear lamps; Lamp mounting height; Brightness; Lamp multiplicity

#### **HS- 009 983 Fld. 5/10**

#### **RUNNING LIGHTS (FOR DAY-TIME USE)**

by Earl Allgaier

American Automobile Assoc.

31 Mar 1965 5p 2 refs

Daytime use of running lights or headlights has been recommended as a safety measure. Running lights consist of one or more lamps of at least 21cp on the front of the vehicle. Some evidence indicates reduction of accidents with daytime lights, but the National Safety Council contends there is insufficient proof of effectiveness. Research could measure present effectiveness, although general use would reduce their attention value.

Search terms: Accident prevention; Headlamp daytime usage; Vehicle visibility; Running lamp daytime usage

#### **HS-009 984 Fld. 5/10**

#### **HEADLAMP INTENSITIES IN EUROPE AND BRITAIN**

by J. S. Yerrell

England Road Res. Lab.

1971 41p 9 refs  
Report no. RRL-LR-383

A survey of headlamp intensities has been made in Britain and four European countries. Meeting beam intensities causing glare and giving near-side illumination were recorded. Averaged intensities in the glare direction in Britain were nearly double those on the Continent, with intensities in France being higher than the continental average and more diverse. Comparison with an earlier survey suggests little change in the glare situation in the United Kingdom in the past eight years. British values were closer than the continental to the relevant beam specification. Illuminating intensities around 4,000 cd were recorded at all four British sites and the single French site, almost double the remaining European figures. There was no correlation between illumination and speed. Tentative conclusions suggest that the British drivers would have seen a standard roadside target 60 m away in 44% of meeting situations on a two-way, single carriageway road, compared with 56% for the French drivers, and 21% for the Belgian.

Search terms: Great Britain; Belgium; Netherlands; Germany; France; Headlamp glare; Lighting measurement; Low beamed headlamps; Headlamp brightness; Sight distances

#### **5/14 Occupant Protection**

#### **HS-009 985 Fld. 5/14**

#### **PASSIVE RESTRAINT WORK BEST PUT IN "SUPERCUSHION" SAYS CHRYSLER**

by Roy Haeusler

Published in *Automotive Engineering* v79 n6 p45-7 (Jun 1971)

Supersedes the previous month's article on the same subject.

The Chrysler Corporation is evaluating a new form of occupant protection: the supercushion. It is intended to protect

people who do not use seat belts or harnesses. This supercushion on the instrument panel and the back of the front seat would absorb far more energy than present dash padding. With adequate development, such a cushion might approach the safety performance of an air bag, but with far greater reliability and lower cost.

Search terms: Crash cushions; Impact tests; Energy absorption; Injury prevention; Passive restraint systems; Cushioning; Occupant protection

#### **5/15 Propulsion Systems**

#### **HS-009 986 Fld. 5/15**

#### **COMPETITION GETS TOUGHER FOR THE INTERNAL COMBUSTION ENGINE**

by Ed Janicki

Published in *Jobber Topics* v101 n5 p88-91, 132, 136 (Jun 1971)

A brief background and status report is given on the Stirling-electric, the General Motors Electrovaair, the rotary piston Wankel, and the Lear turbine engines. The Detroit automobile executives do not see an early substitute for the internal combustion engine.

Search terms: Wankel engines; Stirling engines; Turbine engines; Internal combustion engines; Steam engines; Electric automobiles; Rotary piston engines; Propulsion systems

#### **HS-009 987 Fld. 5/15; 5/4**

#### **CLEAN-AIR BUS**

Anonymous

Published in *Popular Science* v198 n6 p55-6 (Jun 1971)

A Stirling engine design developed by Philips in Holland is nonpolluting and quieter than internal combustion engines. Operation is smooth, and no carburetor, valves, or electrical system

**5/15 Propulsion Systems  
(Cont'd.)****HS-009 987 (Cont'd.)**

are needed. A form cylinder, 200-hp version is planned for buses, a second generation smaller unit for cars. Helium gas sealed in a closed circuit is the working medium with oil fuel and water coolant.

Search terms: Stirling engines; Exhaust emission control; Engine noise; Engine design; External combustion engines; European vehicles

**5/18 Steering Control System****HS-009 988 Fld. 5/18****ALL-WHEEL-DRIVE FOR THE HIGHWAY**

by Joe Lowrey

Published in *Road Test* v7 n8 p58-61 (Aug 1971)

The all-wheel-drive vehicle improves traction on wet roads, lets a driver accelerate on brake in turns without any plowing or tailswing, and permits anti-skid brake control to be more effective at lower cost. Police cars with all-wheel drive are being used in Great Britain and in Michigan. Modifications to the engines are described.

Search terms: Transfer cases; Four wheel drives; Torque; Differentials; Engine modification; Police vehicles; Vehicle stability; Driveshafts

**HS-009 989 Fld. 5/18****TESTS SHOW THAT DEGRADATION OF STEERING, SUSPENSION SYSTEMS DOESN'T ALWAYS AFFECT CAR SAFETY**

by M. R. Belsdorf; R. S. Rice

Published in *Automotive Engineering* v79 n7 p20-4 (Jul 1971)

Based on *Effects of Steering and Suspension Component Degradation on Automobile Stability and Control*, Vol. 3. *Test Results*, HS-800 425.

Road tests and computer simulations show that degradation of the steering and suspension systems of passenger cars has an influence on vehicle stability and control that varies from zero in some cars, to the point where the vehicle may no longer be driven safely. The amount of this variation depends on what component is degraded and how much. Degradation of shock absorbers, ball joints, steering gear, front wheel alignment, stability bar, and steering damper was studied.

Search terms: Steering systems; Suspension systems; Shock absorbers; Steering gear; Vehicle stability; Stabilizer bars; Vehicle control; Wheel alignment; Damping. Ball joints; Degradation failures; Automobile defects

**HS-009 990 Fld. 5/18, 4/7****VALIDATION OF MATHEMATICAL MODELS FOR VEHICLE DYNAMICS STUDIES**

by Richard E. Rasmussen

General Motors Res. Labs.

26 Oct 1964 21p 8 refs  
Report no. GMR-434

Prepared for presentation at the Midwestern Simulation Council, Jan 1964.

Mathematical models for aspects of vehicle ride and directional control were validated against responses of the actual hardware. Rigid body ride equations with seven degrees of freedom were validated in conjunction with a ride motion simulator. Equations representing vehicle bending motions were compared with measured responses. Directional control equations including tire nonlinearities were validated for large step inputs, rapid lane-change maneuvers, and wind gusts. The

directional control equations were more valid than the ride equations. Validation is a worthwhile learning process.

Search terms: Mathematical analysis; Mathematical models; Ride simulators; Vehicle control; Acceleration; Motion; Degrees of freedom; Vehicle riding qualities; Lane changing; Wind forces; Tire forces; Lateral force; Yaw

**HS-009 991 Fld. 5/18; 5/3; 3/4****SHOWDOWN AT MIRA LOMA**

Anonymous

Published in *Air Force Driver* v4 n12 p12-5 (May 1971)

Ordinary motorcycles and full-size cars, with the same operators, were compared on the University of Southern California collision avoidance course. The operators were four Air Force men of ordinary competence. Riding down a center lane, the operator must stop or quickly change lanes when green traffic signals on each lane change color. Cars were better at stopping and maneuvering to the right, about the same on left maneuvers; bikes had poorer braking and maneuvering to the right. At least 120 riders had ridden the same course with similar results.

Search terms: Motorcycle characteristics; Motorcycle riding techniques; Accident avoidance; Automobile handling; Vehicle stability; Stopping distance; Motorcycle handling

**HS-009 992 Fld. 5/18; 5/20****TRACK WIDTHS OF VEHICLES ON CURVES**

by Frederick Jindra

Published in *Traffic Engineering* v32 n12 p15-8 (Sep 1962)

5 refs

A practical method is suggested for constructing maneuverability patterns of turning highway vehicles, based on the

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geometry and kinematics involved. Scale models and tractrix integrators were used to provide diagrams of the paths of the wheels of various types of single and compound vehicles, and off-tracking of trailer combinations. From these, measurements of pavement width requirements and critical vehicle dimensions may be made, and vehicle routing plans established.

Search terms: Tracking; Turning; Articulated vehicles; Offtracking; Scale models; Simulation

**5/22 Wheel Systems**

**HS-009 993 Fld. 5/22**

**THE ECONOMICS OF  
REGULATED SAFETY. 2**

by John F. Floberg

Published in *Rubber World* v164 n1 p55-8 (Apr 1971)

Presented to American Management Association, 16 Apr 1970.

The consumer protection movement is discussed, particularly in regard to tire safety. The tire industry has incurred increased costs because of record keeping, testing, and expenses involved in meeting standards. It is suggested that the public is paying more for the motor vehicle safety program than it is worth so far, but that there are benefits in the increased safety awareness of manufacturers.

Search terms: Consumer protection; Safety standards; Tire industry; Tire safety; Tire standards; Safety standards costs; Economic factors

**HS-009 994 Fld. 5/22**

**THE CHANGING SHAPE OF  
TYRES**

by Charles Blumer

Published in *Motor (London)* v139 n3590 n1-3, 6 (24 Apr 1971)

New trends and developments in tire design are discussed. Tire life, tire temperature, sizes and profile ratios, and diameters are described. The speed and other characteristics of cross ply and radial tires are compared. The properties of rayon, nylon, polyester, glass fiber, and wire tire cord materials are outlined.

Search terms: Tire design; Tire characteristics; Tire cords; Tire diameters; Tire materials; Service life; Tire performance; Aspect ratio; Tire selection; Crossply tires; Radial tires; Nylon tires; Rayon tires; Polyester tires; Fiberglass; Speed; Tire temperature; Wire

**HS-009 995 Fld. 5/22; 5/18**

**TIRES FOR YOUR CAR**

by Jan P. Norbye

Published in *Popular Science* v198 n4 p65-7, 140 (Apr 1971)

Proper tire selection makes a great difference in ride and handling. Aspects described include tire footprints; slip angle from side forces; bias ply versus radial tires; inflation pressures; and steering.

Search terms: Vehicle handling; Tire riding characteristics; Tire inflation pressure; Turning; Steering; Tire selection; Tire side forces; Radial tires; Tire prints; Tire slip motion; Tire traction; Camber; Vehicle riding qualities; Bias belted tires

**NHTSA DOCUMENTS**

**NHTSA Contractors Reports**

**HS-800 369 Fld. 3/5; 3/4**

**DRIVER EDUCATION TASK  
ANALYSIS. VOL. 3.  
INSTRUCTIONAL OBJECTIVES.  
FINAL REPORT**

by A. James McKnight; Alan G. Hundt

Human Resources Res. Organization

Mar 1971 398p  
Contract FH-11-7336  
Report no. HumRRO-TR-71-9

Report for Jul 1970-Mar 1971.

Instructional objectives were developed for driver education courses with an evaluation instrument for assessing the degree to which the objectives have been attained. The objectives are grouped into 74 learning units, each consisting of a statement of purpose, a list of performance objectives, and a description of enabling knowledge and skill objectives. The objectives are grouped into categories representing either major steps toward fulfilling the stated purpose, or groups of similar objectives, and are presented in sequence of normal occurrence. They are also grouped into five levels of criticality. The evaluation instrument comprises three separate tests—the driving fundamentals test, driving situations test, and driving knowledge test.

Search terms: Driver education; Driver skills; Driving task analysis; Behind the wheel instruction; Instruction materials; Driver education manuals; Driver tests; Driving tasks; Driver education evaluation; Driving conditions; Driver behavior; Driver performance

AVAILABILITY: NTIS

**HS-800 370 Fld. 3/5; 3/4**

**DRIVER EDUCATION TASK  
ANALYSIS. VOL. 4. THE  
DEVELOPMENT OF INSTRU-  
CTIONAL OBJECTIVES. FINAL  
REPORT**

by A. James McKnight; Alan G. Hundt

Human Resources Res. Organization

Mar 1971 70p  
Contract FH-11-7336  
Report no. HumRRO-IR-D1-71-1

Report for Jul 1970-Mar 1971.

**NHTSA Contractors Report  
(Cont'd.)****HS-800 370 (Cont'd.)**

The development of instructional objectives for driver education courses and an evaluation instrument to measure attainment of objectives are described. The objectives and evaluation instrument were derived from driving task analysis. Those driving behaviors considered critical for all drivers were organized into a set of performance objectives and standards. Enabling objectives describing the skills and knowledges required in carrying out the performance objectives were prepared. The evaluation instrument comprises an off-road test to measure basic skills involved in controlling the vehicle, a checklist of student responses to driving situations, and 105 information items drawn from enabling objectives. All tests were pilot-tested at a neighboring high school. Recommendations are provided for additional development of the driving situations test.

Search terms: Driver education; Driver skills; Driver education manuals; Driving tasks; Behind the wheel instruction; Instruction materials; Driving task analysis; Driver tests; Driver behavior; Driver education evaluation; High school driving courses; Driver performance

**AVAILABILITY:** NTIS

**HS-800 482 Fld. 5/18****VEHICLE HANDLING. A SIMULATION STUDY OF THE HANDLING PERFORMANCE OF THIRTEEN CONFIGURATIONS OF AN INTERMEDIATE SIZE AMERICAN PASSENGER CAR. FINAL REPORT**

Bendix Corp.

Nov 1970 159p  
Contract FH-11-7571

In this study a comprehensive seventeen degree of freedom vehicle hybrid simulation is used to evaluate the handling characteristics of thirteen configurations of an intermediate size American passenger car. The handling characteristics evaluated included transient and steady state steering, braking, passing acceleration, and overturning stability. An intermediate size American passenger car as it was manufactured was used as the initial configuration. The other twelve configurations were obtained by defining variation of this vehicle's weight and weight distribution, suspension spring rates and shock absorber damping, tire size, and steering wheel inertia. The model's accuracy was verified by comparing the simulated performance of three configurations with results of actual tests.

Search terms: Crosswind; Torque; Vehicle handling; Steering; Braking; Passing; Degrees of freedom; Steady state; Braking; Mathematical models; Vehicle stability; Inertial forces; Lateral acceleration; Steering wheels; Yaw; Vehicle weight; Spring rates; Suspension systems; Simulation models; Acceleration; Tire sizes; Damping; Shock absorbers; Performance tests

**AVAILABILITY:** NTIS

**HS-800 491 Fld. 5/11****PRELIMINARY PROCEDURE ON JACKING SYSTEMS. PASSENGER CARS, MULTIPURPOSE PASSENGER VEHICLES, AND TRUCKS AND BUSES OF 10,000 POUNDS OR LESS GROSS VEHICLE WEIGHT RATING. FINAL REPORT.**

General Testing Labs., Inc.

30 Jul 1970 47p 1 ref  
Contract FH-11-7438  
Report no. A-3360-3-1

Tests of jacking systems were conducted to determine that the vehicle would not fall off the jacking device, nor would any

part of the device collapse or fail to function. The bearing pressure of each vehicle on its jack was also checked against the requirements of the DOT Preliminary Procedure on Jacking Systems.

Search terms: Jacks; Performance tests; Jacking; Compliance tests; Loading tests

**AVAILABILITY:** NTIS

**HS-800 492 Fld. 5/1; 5/2; 5/20****BUS, TRUCK, TRACTOR-TRAILER BRAKING SYSTEM PERFORMANCE. VOL. 1 OF 2. RESEARCH FINDINGS. FINAL REPORT.**

by R. W. Murphy; R. Limpert; L. Segal

Michigan Univ. Hwy. Safety Res. Inst.

Mar 1971 270p  
FH-11-7290

Report no. HSRI-70-101(PF-101)-Vol-1

Report for Jul 1969-Mar 1971.

The objectives of this study were to determine the range of braking performance currently exhibited by buses, trucks, and tractor-trailers and to establish the maximum braking performance capabilities of these vehicles based upon full utilization of the technology related to brake system design. Both vehicle testing and analytical techniques, including dynamic modeling and simulation, were used to accomplish these objectives. Performance measures were defined which serve to quantify the degree to which a given braking system possesses those qualities necessary for adequate braking performance. Using these measures, a braking performance standard is recommended based upon a comparative analysis of current braking performance, the maximum performance achievable by full exploitation of existing technology, and performance as constrained by a host of associated factors.

Search terms: Brake performance; Brake system design; Brake fade; Braking; Deceleration; Buses; Tractor trailers; Performance tests; Dynamic models; Braking distances; Brake standards; Coefficient of friction; Brake failures; Mathematical models; Hydraulic brakes; Disc brakes; Brake proportioner systems; Brake tests; Truck brakes; Simulation models; Brake thermal factors

AVAILABILITY: NTIS

**HS-800 493 Fld. 5/1; 5/2; 5/20**

**BUS, TRUCK, TRACTOR-TRAILER BRAKING SYSTEM PERFORMANCE. VOL. 2 OF 2. APPENDICES AND REFERENCES. FINAL REPORT.**

by R. W. Murphy; R. Limpert; L. Segal

Michigan Univ. Hwy. Safety Res. Inst.

Mar 1971 132p 329 refs  
Contract FH-11-7290  
Report no. HSRI-70-101(PF-101)-Vol-2

Report for Jul 1969-Mar 1971.

The objectives of this study were to determine the range of braking performance currently exhibited by buses, trucks, and tractor-trailers and to establish the maximum braking performance capabilities of these vehicles based upon full utilization of the technology related to brake system design. Both vehicle testing and analytical techniques, including dynamic modeling and simulation, were used to accomplish these objectives. Performance measures were defined which serve to quantify the degree to which a given braking system possesses those qualities necessary for adequate braking performance. Using these measures, a braking performance standard is recommended based upon a comparative analysis of current braking performance, the maximum performance achievable by full exploitation of existing technology, and performance as constrained by a host of associated factors. Recommendations for brake standards are included.

Search terms: Brake tests; Brake system design; Braking; Buses; Tractor trailers; Brake performance; Instrumented vehicles; Brake failures; Tire road contact forces; Coefficient of friction; Loading tests; Mathematical models; Performance tests; Truck brakes

AVAILABILITY: NTIS

**HS-800 494 Fld. 5/1; 5/2; 5/20**

**BUS, TRUCK, TRACTOR-TRAILER BRAKING SYSTEM PERFORMANCE. SUMMARY FINAL REPORT.**

by R. W. Murphy; R. Limpert; L. Segal

Michigan Univ. Hwy. Safety Res. Inst.

Mar 1971 51p  
Contract FH-11-7290  
Report no. PF-101a

Report for Jul 1969-Mar 1971.

The objectives of this study were to determine the range of braking performance currently exhibited by buses, trucks, and tractor-trailers and to establish the maximum braking performance capabilities of these vehicles based upon full utilization of the technology related to brake system design. Both vehicle testing and analytical techniques, including dynamic modeling and simulation, were used to accomplish these objectives. Performance measures were defined which serve to quantify the degree to which a given braking system possesses those qualities necessary for adequate braking performance. Using these measures, a braking performance standard is recommended based upon a comparative analysis of current braking performance, the maximum performance achievable by full exploitation of existing technology, and performance as constrained by a host of associated factors. Recommendations for brake standards are included.

Search terms: Brake system design; Braking; Buses; Tractor trailers; Dynamic models; Braking distances;

Brake standards; Brake performance; Brake fade; Deceleration; Brake failures; Truck brakes; Coefficient of friction; Antilocking devices; Performance tests; Brake tests

AVAILABILITY: NTIS

**NHTSA Staff Speeches, Papers, etc.**

**HS-810 163 Fld. 3/1**

**WHAT THE U.S. DEPARTMENT OF TRANSPORTATION IS DOING ABOUT THE DRINKING DRIVER**

by Robert B. Voas

National Hwy. Traf. Safety Administration

1971 20p

Prepared for presentation at the Ottawa Road Safety Workshop, Ottawa, Canada, 29 Jan 1971.

The Department of Transportation's Alcohol Countermeasures Program is described. The program is based on the concept drawn from currently available research that one-third of all highway fatalities are attributed to problem drinker-drivers or pedestrians, and that another 16% of such fatalities in the U.S. are attributable to social drinkers who occasionally abuse alcohol and drive.

Search terms: Drinking drivers; Alcohol education; Alcohol usage deterrents; Driver intoxication; Alcoholism

**HS-810 169 Fld. 3/1**

**CARS THAT DRUNKS CAN'T DRIVE**

by Robert B. Voas

National Hwy. Safety Bureau

1970 37p 22 refs

## NHTSA DOCUMENTS

### NHTSA Staff Speeches, Papers, ect. (Cont'd.)

#### HS-810 169 (Cont'd.)

Prepared for presentation at the annual meeting of the Human Factors Society, San Francisco, Calif., 15 Oct 1970.

Methods of identifying problem drinking drivers and preventing them from operating a car are discussed. Only breath tests seem to be practical means of measuring blood alcohol levels. Various tests of a person's fitness to drive which have been considered for use in an interlock system are briefly discussed. Means to prevent the driver, whose license has been suspended, from driving are mentioned. Problems with interlock systems include: embarrassment of other drivers of the problem drinker's car; interference with the problem drinker's means of earning a living; and cost and reliability of the system used.

Search terms: Driver intoxication; Alcohol detection and interlock systems; Blood alcohol levels; Drinking drivers; Alcohol breath tests; Driver physical fitness

#### HS-820 160 Fld. 1/3; 4/4

### ACCIDENT INVESTIGATION AND REPORTING ACTIVITIES OF THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION. ANNUAL REPORT FOR 1970 TO THE SECRETARY, DEPARTMENT OF TRANSPORTATION

by J. Watt; E. Flamboe; S. Lee; J. Ketyeski; D. Bischoff; J. Fell; E. Weinstein

National Hwy. Traf. Safety Administration

Apr 1971 52p 12 refs  
Report no. AR-1

This first report on the accident investigation and reporting activities of the National Highway Traffic Safety Administration (NHTSA) describes the functions of the multi-level investigation system and its various approaches to accident investigations, including cooperation with the National Transportation Safety Board (NTSB). Five accident cases which were investigated are reported, and their findings and recommendations

demonstrate the approaches being taken by NHTSA. Investigation of accidents by NHTSA's multidisciplinary teams has been hindered by a lack of cooperation on the part of those involved, apparently from fear that their rights may be prejudiced if the case has not been settled. Some method is needed for collecting and analyzing accident data that will protect the parties involved from compromise, and the recommendation is made that all Department of Transportation agencies be granted investigative power similar to that of the Federal Aviation Administration and NTSB.

Search terms: Multidisciplinary teams; Federal state relationships; Accident investigation; Accident causes; Fatality causes; Accident research; Bilevel accident investigation; Trilevel accident investigation; Accident studies; Injury causes; Accident case reports



# executive summary

## A SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

ANNUAL REPORT TO THE SECRETARY OF TRANSPORTATION ON  
ACCIDENT INVESTIGATIONS AND REPORTING ACTIVITIES  
OF THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION  
APRIL 1971  
DOT/HS-820 160

### PURPOSE

The Department of Transportation (DOT) Order 2000.1 entitled, "Relationships Between the National Transportation Safety Board and the Operating Administrations, Department of Transportation, Office of the Secretary" dated October 31, 1968, makes it obligatory for an annual report to be submitted each year by each of the operating administrations to the Secretary. The reports are for the most part concerned with accident investigation and reporting.

The purpose of DOT Order 2000.1 is to insure:

- the establishment of uniform procedures within the DOT for acting upon recommendations made by the National Transportation Safety Board (NTSB), and
- review periodically the relationships between NTSB and the operating administrations in the conduct of the accident investigation and reporting function.

The theme of each report, in addition to a summary of activities, is to:

- assess the effectiveness of the statutory scheme for dealing with accident investigations;
- identify any problem areas existing in the relationships or communication between NTSB and the operating administration; and
- recommend any necessary changes in procedures, relationships, or basic legal authority.

This is a synopsis of the first report of such activities to the Secretary by what is now the National Highway

Traffic Safety Administration. Previous reports to the Secretary were the combined efforts of the Bureau of Motor Carrier Safety and the National Highway Safety Bureau under the Federal Highway Administration.

### Congressional Acts Provide Investigative Authority

The accident investigation and reporting activities of the National Highway Traffic Safety Administration (NHTSA) have two statutory bases:

1. The Highway Safety Act of 1966 provides authority to the NHTSA to conduct or sponsor motor vehicle accident investigations in order to assess accident and injury causation and make recommendations for Traffic Safety Programs to aid in alleviating the accident problem.
2. The National Traffic and Motor Vehicle Safety Act of 1966 provides for the same investigative authority in order to aid in promulgating Motor Vehicle Safety Standards.

### The Programs

The accident investigation and reporting activities conducted under these activities encompass a wide range of programs; basically, these involve:

- Accident Investigation Systems Design
- Federal "GO" Team
- Multidisciplinary Teams
- Tri-level Studies
- Bi-level Studies

Relationships with the NTSB have existed in each of those five basic areas:

## Activities

The report describes, in detail, the accident investigation and reporting activities of five NHTSA programs. The functional capability of each program and examples of the contributions made with respect to furthering the knowledge of accident and injury causation are reviewed.

### ● Accident Investigation Systems Design (AISD)

Accident investigation provides information about the real-world problems encountered by drivers during the operation of their vehicles. The study of accident and injury causation leads to remedial action to these problems and serves to indicate the success or failure of those remedies enacted. Satisfactory achievement of these objectives is fundamental to the success of the entire highway safety mission. NHTSA has therefore established an Accident Investigation Systems Design group whose function is to insure the development of a national accident investigation and reporting system that will serve these objectives.

- Accomplishments

Their efforts to date have been directed toward:

- devising and implementing a multi-level collision investigation system which is national in scope;
- developing new techniques, procedures and instrumentation to improve crash investigation; and
- sponsoring of conferences and symposia for the exchange of information dealing with findings and accident investigation methodology.

### ● Federal "GO" Team

A Federal "GO" Team was organized to:

- provide better coverage of high priority, special interest collisions (buses, both school and commercial; multi-vehicle crashes; trucks carrying hazardous materials, etc.) as required by the NTSB,

- provide coordination between Federal and State collision investigation programs,

- provide for field testing new methods and equipment and assist in the implementation of new technology at the State level.

### ● Multidisciplinary Teams

The NHTSA sponsored 17 accident investigation programs during the calendar year 1970. Fourteen of those efforts were Multidisciplinary Accident Investigation Teams; these Teams have continued to conduct in-depth motor vehicle collision investigations. The three remaining efforts include two Tri-level studies and one Bi-level study; these are described briefly in this summary.

• Multidisciplinary Teams consist of various medical specialists including pathologists, toxicologists, and psychiatrists, and members of other safety-related disciplines such as highway engineers, automotive or mechanical engineers, police technicians, lawyers, and psychologists. The Teams are chosen from various universities and research centers and provide logical geographic coverage across the country. The objectives of these teams are to:

- identify all factors which contribute to a collision,
- identify what factors produced the injuries involved,
- evaluate the effectiveness of new safety features,
- evaluate Federal Motor Vehicle Program Standards,
- evaluate Federal Traffic Safety Program Standards, and to
- detect at an early stage of the investigation, the design and functional problems of the vehicle and the highway.

- The in-depth investigation includes a careful analysis of the basic elements of the collision: human vehicle, and environmental factors. Three phases of the traffic system failure are also examined: pre-crash, crash, and post-crash. Causal factors, findings, conclusions, and recommendations are classified according to a pre-established

highway safety program matrix. The results of these analyses provide necessary insight into possible areas that may be affected by Traffic Safety and Motor Vehicle Programs. At the time of submission of the report to the Secretary over 700 in-depth accident cases have been submitted to NHTSA. These cases have been summarized by the NHTSA and a total of over 3000 causal factors, findings, conclusions of recommendations have resulted. Many of the 3000 factors have repeatedly emanated from case reports.

#### ● Tri-level Studies

A tri-level effort is one that collects three levels of information on accidents in order to provide statistically valid information concerning motor vehicle accidents. Two tri-level projects were implemented to:

- collect accident and exposure data on a region-wide basis in order to determine accident rates for various classes of vehicles and drivers,
- obtain vehicle damage and injury severity data for accidents involving late model vehicles, and
- perform selected in-depth investigations of accidents involving late model vehicles.

One of the tri-level projects is concentrating on determining the extent to which vehicle defects, malfunctions, and subsystem maladjustments cause and contribute to crashes. The other tri-level effort is concerned with the determination of significant accident and injury causal factors in a given "universe" of accidents.

#### ● Bi-level Studies

A bi-level study involves the collection of specific information in addition to standard police reports on each accident occurring in a geographic region. The bi-level investigations are conducted by police or personnel with a similar level of training. Their purpose is to collect certain data elements, limited in number, in addition to the normal police report. This method is used to investigate specific problem areas. Those data elements studied will change as new problem areas are defined.

### ASSISTANCE AND COORDINATION WITH NTSB

Each of the five basic NHTSA accident investigation program activities has included as an integral part of its

operation, direct liaison with NTSB and other interested user groups.

For the past two years, representatives of the Accident Investigation Systems Design group have served on a DOT Intra-agency Accident Investigation Coordination Committee. The purpose of this committee has been to devise and implement a procedure whereby various DOT elements having an interest in accident investigation activities would respond to an accident in a coordinated manner. A procedure has been developed to establish a notification system that monitors and receives word of accidents, determines when an accident meets study criteria, and designates which representative agency will be in charge of investigation efforts. This procedure will be fully implemented when it has received final concurrence by all agencies involved.

Members of the Federal "GO" team have continued to assist the NTSB in the investigation of accidents that meet NTSB study criteria. However, the manpower available to assist the NTSB investigations continues to be the dominant problem confronting Federal "GO" team in addition to other full-time duties. As a result, their activities with respect to accident investigation are quite limited. This in turn serves to produce considerable delays in completing their duties as members of the "GO" team.

### THE PROBLEM CONFRONTING ACCIDENT INVESTIGATIONS

#### Statutory Assessment Personel Immunity and Vehicle Impoundment

The goal of motor vehicle accident research as performed by the NHTSA is to determine those factors which serve to influence the initiation of motor vehicle accidents and the resultant losses incurred. Through the scientific study of accidents as they happen, remedies may be developed that serve to reduce the recurrence of such accidents or ameliorate their consequences. The cooperation of those directly involved in motor vehicle accidents, as well as witnesses thereto, must be obtained in order that these accidents may be so studied.

Under the present legal structure persons involved in motor vehicle accidents may be liable to criminal or civil action. This fact is stressed by insurance companies and legal counselors in order that a person may act to protect his legal rights. They recommend that a person offer no information beyond that required by law in order that he does not unnecessarily incriminate himself. It is right that the public be so protected. However, insuring that such protection is guaranteed serves to

inhibit the collection of scientific evidence that may be studied and used in the development of accident and injury prevention programs.

Although the data collected for NHTSA's accident investigation programs are for research purposes only, under the present legal system, the data and/or the investigators may be subpoenaed in later legal action. In most cases, the data necessary to determine the causes of an accident or resultant injury coincides with data necessary to prove fault. The individual involved in an accident must therefore evaluate the legal implications of cooperating with research scientists and determine if his cooperation is in keeping with his best personal interests. Unfortunately, for both the scientist and the public whom he represents, the individual must frequently deny any cooperation with scientific efforts in order to insure against later legal involvement.

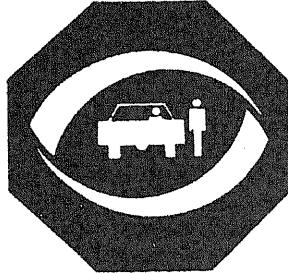
#### ● Recommendations and Conclusions

A potential method both guarantee individual rights and insure the collection of viable accident data is to provide NHTSA with legal authority to collect such data and to give privileged status to that information so collected for research purposes, thereby preventing its use in subsequent legal action. If this, or a similar approach is not taken, NHTSA must continue to act under a highly constrained system of data collection which has and

continues to prevent the orderly and timely development of information necessary to its safety efforts. The NHTSA has extensive documented evidence to support this appeal.

In conclusion, the present available methods to insure the protection of individual rights while collecting scientific data regarding accidents have proven ineffective. To some degree, neither program objectives nor the protection of individual rights have been safe from compromise. In the search for a satisfactory mechanism to remove this aura of compromise, the NHTSA has examined those legislative authorities granted to existing Federal safety-related agencies such as the Federal Aviation Administration and the National Transportation Safety Board. A thorough examination has been conducted of the empowered capabilities of these agencies. The NHTSA has concluded that most of the above hindrances to its investigation activities would be removed if all Department of Transportation agencies were granted similar authority with respect to the investigation and study of accidents. An amendment of the National Traffic and Motor Vehicle Safety Act to this effect is presently under consideration for submission to the current U. S. Congress.

Availability: This report may be ordered in paper copy (PC) at \$3.00 per copy or microfiche (MF) for 95¢ from NTIS. Order by DOT/HS-820 160.



# executive summary

## A SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

### MAXIMUM SPEED LIMITS FINAL REPORT

The purpose of the contract was to determine and recommend an optimum method for establishing maximum speed limits that could be widely implemented utilizing existing technology and manpower resources.

Contract FH-11-7275  
Indiana University  
400 East Seventh Street  
Bloomington, Indiana 47401

Award Amount: \$62,555.00  
Contract Period: June 20, 1969  
to September 30, 1970

DOT/HS-800 378 A Study for the Selection of  
Maximum Speed Limits, Vol. I  
PB-197 373

DOT/HS-800 390 A Programmed Implementation Manual  
for Setting a Speed Limit Based  
on the 85th Percentile, Vol. III  
PB-197 375

DOT/HS-800 379 The Development of Speed Limits  
A Review of the Literature, Vol. II  
PB-197 374

DOT/HS-800 381 An Implementation Method for  
Setting a Speed Limit Based on  
the 85th Percentile Speed, Vol. IV  
PB-197 376

#### General Comments

The report is presented in four volumes as noted above. Volume I contains the technical portion of the report including a summary review of relevant literature. Volume II presents an extensive review of the literature concerning speed and speed control. Volume III is an implementation manual consisting of detailed instructions for establishing an appropriate speed limit. This volume is designed for use by a person who is not familiar with speed control methods. Volume IV is a brief explanation of the recommended method to be used by the experienced traffic engineer.

#### Specific Objectives

The specific objectives of the study were to:

1. Present a comprehensive summary of existing methodology relating to speed control and the establishment of speed limits.
2. Survey state and local jurisdictions to identify current practices in establishment of speed limits.

3. Identify the availability of technical resources (at state and local levels) that could be utilized in establishing speed limits.
4. Develop an operational explanation of the function and objectives of speed limits.
5. Select the best, real-world conceptual approach for the establishment of speed limits.
6. Conduct analytical investigations to validate such concepts.
7. Develop a statistically valid method of establishing speed limits that can be implemented utilizing existing technology and manpower resources.
8. Identify such research as may be necessary to further refine the "state of art" of speed control and the establishment of speed limits.

## RESULTS

The research plan included an extensive review of existing research literature, an evaluation of identified methods, collection and analysis of data utilizing a Computer-Sensor System to validate existing methods, and the development of a programmed instruction text to implement the recommended method.

### Literature Review

The literature review considered more than 300 documents relating to the history of speed limits; the relationship of speed and speed limits; driver speed behavior and variables, other than speed limits which influence it; the relationship of speed, speed limits, and accidents; and methods for establishing speed limits.

### National Survey

Questionnaires were sent to traffic engineers of all state highway departments, all cities over 100,000 in population, and 52 selected cities with populations under 100,000. The response was 88% which indicated that the following items were most frequently considered in establishing speed limits:

- 85th percentile
- ball-bank indicator data
- accident experience
- length of zone and adjacent zone
- design speed
- pace
- spacing of intersections and driveways
- traffic volume
- presence and condition of shoulders
- average test run speed
- presence of pedestrians
- traffic signals and controls

The survey also showed the general availability of radar, vascar, ball-bank indicator, and vehicle counters to measure vehicle speed, traffic characteristics, and roadway features.

### Evaluation and Development of a Method

The various techniques for establishing speed limits identified as a result of the literature review and the survey of jurisdictions were subjected to a screening analysis to identify those methods worthy of further consideration for full-scale implementation. The analysis revealed these such techniques:

- Taylor's theory of speed distribution skewness
- Oppenlander's cost-oriented approach
- The 95th percentile method

A third data source was also used, which consisted of speed data collected through a unique Computer-Sensor System. This computer system allowed detailed examination of existing speed limit concepts and validation of the recommended statistical method for implementation. It also provided a further basis for selecting a recommended technique from the three techniques identified by the screening analysis. Use of the computer system showed a strong relationship between deviation of the speed of the accident-involved vehicle from the mean speed of the traffic stream.

It also showed that the cumulative accident involvement rates were acceptably flat (i.e., independent of speed) until the speed deviation reached a point corresponding to the 85th percentile speed after which it started to rise at a precipitous rate.

### CONCLUSIONS AND RECOMMENDATIONS

The final result of the study effort was to recommend that maximum speed limits be established on the basis of the 85th percentile of travel speeds. Such a limit is:

1. Fundamentally fair in the context of the Traffic Law System.
2. Related to risk of dysfunction in the Surface Road Transportation System.
3. Accepted as reasonable by drivers.
4. Applicable to a wide range of highways.
5. Capable of being implemented with existing resources

- O -

The Contract Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration.

**Availability:** NTIS. Those interested in obtaining this research study should obtain all volumes as a package. Order from NTIS, U. S. Department of Commerce, Springfield, Virginia 22151;

- Vol I DOT/HS-800 378 or PB-197 373
- Vol II DOT/HS-800 379 or PB-197 374
- Vol III DOT/HS-800 380 or PB-197 375
- Vol IV DOT/HS-800 381 or PB-197 376

Each volume sells for \$3.00 in paper copy (PC) or 95¢ in microfiche (MF).

**U.S. DEPARTMENT OF TRANSPORTATION**

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